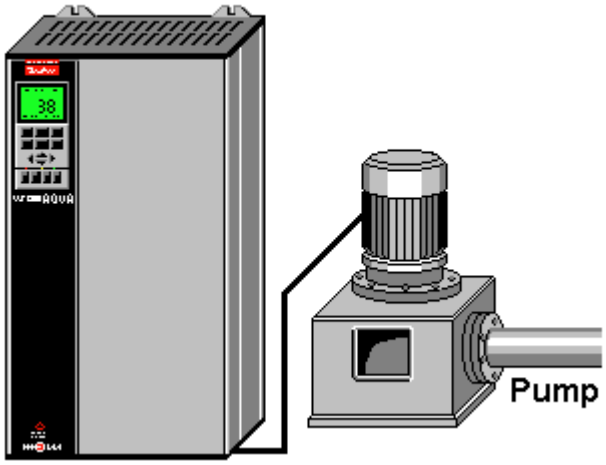
ALBERTA AGRICULTURE AND RURAL DEVELOPMENT

Variable frequency drive corner arm pivot case study

Part 1: Instrumentation and data collection equipment

Prepared by: Gregg Dill, P.Eng.

December 2011



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SUMMARY

A corner arm centre pivot operates about 20% of a circle at the maximum flow rate and 80% of the circle at flow rates lower than the maximum flow rate. A typical flow rate range is 700 to 1200 gpm. A corner arm centre pivot pumping unit is designed to deliver the maximum flow rate at the maximum pressure and, therefore, operates at lower flow rates and higher pressures for most of the circle. The variable frequency drive (VFD) adjusts the motor speed to allow the pump to deliver the required flow rate at the required pressure which, effectively, reduces the kilowatts of power required for most of the circle.

Instrumentation and data collection equipment required to test the power requirement for a corner arm centre pivot without a VFD, with a VFD controlled by a pressure transducer at the pump discharge and with a VFD controlled by a pressure transducer at the corner arm tower was assembled and tested.

Instrumentation will include an ultrasonic flow meter or a propeller flow meter, two wired pressure transducers, three wireless pressure transducers, a power meter on the irrigation system service input, a power meter on the input to the VFD, a wireless GPS receiver on the last tower of the centre pivot, a wireless GPS receiver on the corner arm, and a speed monitor on the pump/motor.

The monitoring system was successfully assembled and tested.

INTRODUCTION

A corner arm centre pivot operates about 20% of a circle at the maximum flow rate and 80% of the circle at flow rates lower than the maximum flow rate. A typical flow rate range is 700 to 1200 gpm. A corner arm centre pivot pumping unit is designed to deliver the maximum flow rate at the maximum pressure and, therefore, operates at lower flow rates and higher pressures for most of the circle. The variable frequency drive (VFD) adjusts the motor speed to allow the pump to deliver the required flow rate at the required pressure which, effectively, reduces the kilowatts of power required for most of the circle.

This project will measure the energy consumption of a pumping unit, controlled with and without a VFD, for a corner arm centre pivot irrigation system and identify potential energy savings. Each system will be monitored without a VFD, with a VFD controlled by a pressure transducer at the pump discharge, and with a VFD controlled by a pressure transducer at the corner arm tower. Four systems will be monitored; 1) centrifugal pump and a level field, 2) centrifugal pump and an unlevel field, 3) turbine pump and a level field, and 4) turbine pump and an unlevel field. A trailer-mounted VFD will be moved to each site and connected to the power panel of the pump for each of the four existing corner arm centre pivot irrigation systems. Mounting the pressure transducer at the end of the corner arm requires a wireless system which may add $4,000 to the cost of the VFD option.

The monitoring system was successfully assembled and tested.

INSTRUMENTATION

Instrumentation will include an ultrasonic flow meter or a propeller flow meter, two wired pressure transducers, three wireless pressure transducers, a power meter on the irrigation system service input, a power meter on the input to the VFD, a wireless GPS receiver on the last tower of the centre pivot, a wireless GPS receiver on the corner arm, and a speed monitor on the pump/motor. Information on sensor and instrumentation manufacturers, model numbers and suppliers is provided in Appendix A. Brochures and more detailed technical information about the sensors and instrumentation are included in Appendix D.

The instrumentation and data collection developed and assembled for the 2009 *Irrigation system energy trial assessment project* will be used as the basis for this project. In the 2009 project, data from the pressure transducers and the flow meter were recorded on a CR10 data logger and the power meter data was stored in each of the two power meters as the meters did not have a communication port. This lead to a great amount of time spent synchronizing the data from all three data loggers to ensure the power meter data was for the same time period as the pressure and flow data. All data, including the two power meters data, will be collected and stored on one data logger to eliminate time discrepancies. GPS data and pump speed (not collected in the 2009 project) will also be collected by the same data logger eliminating the need to try and synchronize data from different data loggers to the same time. The data logger will be located at the edge of the field near the electrical power panel.

Data logger

A Campbell Scientific Inc. (CSI) CR1000 data logger will be used to collect and pre-process the data. The data signal from the power meters will be converted from RS485 to RS232 and connected to COM ports one and two on the data logger. The RS232 signals from the two GPS receivers will be connected to COM

ports three and four on the data logger. Power and communication requirements for each instrument and sensor are discussed below. CR1000 channel assignments are shown in Table 1.

Table 1: VFD case study Campbell Scientific CR1000 data logger channel assignments.

Channel	Source	Parameter	Signal type	Units	Range
1	Flow meter	Flow rate	4-20 ma	GPM	0-1500
2	Inlet pressure transducer	Inlet pressure	0.5-5.5 VDC	PSI	-14.7 to 15
3	Discharge pressure transducer	Discharge pressure	0-5 VDC	PSI	0-100
4	Pivot point pressure transducer	Pivot point pressure	4-20 ma	PSI	0-100
5	Pivot end pressure transducer	Pivot end pressure	4-20 ma	PSI	0-100
6	Corner arm pressure transducer	Corner arm pressure	4-20 ma	PSI	0-100
P1	Tachometer	Pump speed	0-5 VDC	RPM	0-2000
COM1	Power panel power meter	Supply power	RS485/RS232	kW, kWh, Amps, V, PF	various
COM2	VFD input power meter	VFD power	RS485/RS232	kW, kWh, Amps, V, PF	various
COM3	Pivot end GPS	Pivot end position	RS232	northing/easting	various
COM4	Corner arm GPS	Corner arm position	RS232	northing/easting	various

Flow meter

A GE Panametrics PT878 ultrasonic flow meter will be used to record system water flow rate data using the CR1000 data logger at the same time interval as all the other test parameters. A 4-20 ma output cable, supplied by GE Panametrics (p/n 704-609), will be required to transfer the instantaneous flow rate data to the data logger.

A McCrometer M0308 McPropeller flow meter with McCrometer McSpaceSaver FS100 flow straightener vanes will be used on systems that do not have the required pipe length before and after the ultrasonic flow meter to ensure the required ±2% accuracy required. A McCrometer EA631 pulse transmitter will be required to transmit the signal to the CR1000 data logger.

Power meters

Two Acuvim II power meters will be used to monitor power quality parameters. Data recorded will include volts, amps and power factor for each leg of the 3-phases, kilowatts and kilowatt hours for each test circle. MODBUS protocol will be used to transmit data to the data logger from the Acuvim II meters. The data output from the power meters will be transferred using RS485 MODBUS protocol and converted to RS232 protocol using two BlackBox IC820A converters connected to COM ports 1 and 2 on the CR1000 data logger. Power for the meters will be supplied from a 120 VAC source or from the lines being monitored. The RS485/RS232 converters must be powered from the 12 V Power out connection of the CR1000 to ensure a common ground. The Rx Com wire (C2 on the CR1000 wiring panel) will be connected to the RS232 pin 2 and the Tx Com wire will be connected to RS232 pin 3. A ground must be connected from the CR1000 Power out connection on the CR1000 wiring panel to the RS232 pin 5 to ensure there is a common ground.

Initial communication with the Acuvim II was unsuccessful. MODBUS protocol has not been used previously at the Agtech Centre for data collection. During the troubleshooting process, it was found that, although MODBUS is a standard communication protocol, it requires specific software (above), to analyse the data available from the Acuvim II. Many calls were made to suppliers for information and the procedure to resolve the communication problem. Finally, one suggested downloading a tool to display the data to ensure the communication settings were correct and to determine the actual format of the data. A demo version of *ModScan32* (WinTECH.com) was downloaded and used to confirm the communication settings and the register data documented in the Acuvim II User's Manual. Many possible

combinations were configured and tested unsuccessfully before the registers containing the required data were identified. It was found that the data did not start from the register indicated in the Acuvim II manual.

Since this is a unique combination of instruments, there was no specific documentation on power and data signal requirements. The CR100 CRBasic program *Acuvim_test.ComRS232.CR1* (Appendix A) , supplied by a Campbell Scientific Inc. Applications Engineer contacted in the troubleshooting process, was used with a CR1000KD display/keyboard as an intermediate step to confirm the data was available from the Acuvim II as documented. The next step was to confirm the data was available at the CR1000 COM1 port. A power configuration problem was identified during the testing process. Power for the RS485/RS232 converter was originally supplied using a standard 120 V transformer to provide the 12 VDC power required. With the help of the CSI Applications Engineer, it was identified that the power must be supplied from the CR1000 Power out connection and a ground wire provided from the CR1000 Power out connection to the converter to ensure a common ground to stabilize the data signal. The CRBasic program *Acuvim_test.Com1.CR1* (Appendix B) was developed and used to setup the MODBUS communication between the Acuvim and CR1000 data logger. The frequency data was not available in the location indicated in the Acuvim II documentation.

Pressure transducers

Pressure transducers will be located on the intake and discharge of the centrifugal pumps and on the discharge of the turbine pumps. The distance from the water level to the pump discharge will be measured for the turbine pumps. Wireless pressure transducers will be located at the pivot point, last tower and corner arm tower and the data will be transmitted to the data logger using Phoenix Contact 900 MHz radios. The VFD will be controlled by the discharge pressure transducer for one complete circle and by the corner-arm pressure transducer for one complete circle.

GPS

The John Deere Starfire iTC GPS was selected for identifying the location of the end of the pivot and the corner-arm to use in determining the effect of elevation on the head required at the pump and to identify the additional head required due to elevation. The data will also be used to identify the location of the pivot in the 360 degree rotation. The StarFire receiver will be activated for real time kinematic (RTK) accuracy (±2 cm). A 12 VDC power supply will be required for each GPS unit.

One receiver will be established as a base station at each test site and receivers will be positioned on the last tower of the pivot and on the corner-arm tower. The base station will be in position for at least 24 hours prior to data collection at each test site to establish base station criteria for the site. The pivot end and corner-arm tower location data will be transferred through a Phoenix Contact 900 MHz wireless connection from the receivers to the CR1000 data logger located at the pump site. This will ensure that the pivot location will be recorded at the same time as the power, pressure, speed and flow data.

The StarFire was chosen to be consistent with the GPS supplier currently used at the Agtech Centre. Communication between the computer and the receiver will be through a John Deere StarFire iTC Radar harness (PF80754) that includes a RS232 serial connection. A baud rate of 4800 will be required to communicate with the StarFire iTC receiver. A 12 VDC power supply will be connected to power the receiver through the round, 4-pin connector on the harness.

The StarFire (SF) GPS receiver is usually used as part of the John Deere guidance system rather than as a stand-alone receiver used to provide position data to a data logger application. A specific

communication wiring and communication procedure was not available and had to be developed step by step with several calls to the supplier and many false starts. The first step was to identify the correct wiring harness to connect the receiver and the computer. Identifying the correct wiring harness was prolonged until it was recognized that the Panasonic Toughbook laptop used to communicate with the receiver had an internal GPS system that had to be disabled before communication with the SF unit was possible. Once the internal GPS was disabled, the software package LabView was used, as an intermediate step, to view the data stream provided by the receiver as a NMEA string and to understand the format of the data. The data format was found to be different than that documented in the software.

The next step was to use the Toughbook to communicate with the receiver without using Labview. After searching the internet, a software program, *iTCconfig,* available from the John Deere website http://stellarsupport.deere.com/en_US_new/categories/tools/starfire-desktop-configurator was used to interface with the StarFire receiver to set the communication parameters. This program must be used to set the required communication parameters on the receiver to enable communication with the CR1000 data logger. The *iTCconfig* software used to communicate with the iTC receiver will not communicate with the StarFire 3000 receiver that is available at the Agtech Centre and compatible software was not available.

After the communication parameters were set on the StarFire receiver, the receiver was connected directly to the CR1000 data logger and the CRBasic program *GPS_SF2.test.CR1* (Appendix C) was used to confirm the NMEA string data available to the CR1000 data logger from the GPS receiver through a RS232 interface connected to COM3. The second GPS receiver will be connected to COM4. The output is shown in Table 2. The data will be imported into an Excel spreadsheet and formatted (Table 3).

The data will be imported into an Excel spreadsheet *(circle_calc.xls)* and the location data will be used to determine the location of the pivot and corner-arm relative to the pivot centre and the elevation relative to the pump elevation (Table 4).

Table 2: Data format of data sent to the CR1000 data logger from the StarFire iTC GPS receiver.

"TOA5","CR1000","CR1000","29911","CR1000.Std.18","CPU:GPS_SF2_test2.CR1","57902","gpsdata"
"TIMESTAMP","RECORD","ggaid","ggautc","ggalatitude","ggan_s_ind","ggalongitude","ggae_w_ind","ggapositionfix","gganumsatellites","ggahdop","ggaaltitude","ggaaltutudeunits","ggageoidsep","ggageoidunits"
"TS","RN","","","","","","","","","","","","","",""
"","","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp"
"2011-10-20 16:43:00",454,"$GPGGA","224258.0","4939.558750","N","11248.469532","W","1","06","2.2","913.447","M","-16.143","M"
"2011-10-20 16:44:00",455,"$GPGGA","224358.0","4939.558729","N","11248.469352","W","1","07","2.1","913.574","M","-16.143","M"
"2011-10-20 16:45:00",456,"$GPGGA","224458.0","4939.558256","N","11248.469782","W","2","07","2.3","913.803","M","-16.143","M"
"2011-10-20 16:46:00",457,"$GPGGA","224558.0","4939.558549","N","11248.470141","W","2","07","2.1","906.469","M","-16.143","M"
"2011-10-20 16:47:00",458,"$GPGGA","224658.0","4939.558801","N","11248.470377","W","2","07","2.2","906.128","M","-16.143","M"

Table 3: StarFire iTC GPS data as it appears when opened in an Excel spreadsheet as a csv file.

Timestamp	Record	id	utc	latitude	n_s ind	longitude	e_w ind	position fix	num of satellites	hdop	altitude	alt units	geoid sep	geoid units
10/20-16:43	454	$GPGGA	224258	4939.55875	N	11248.469532	W	1	6	2.2	913.447	M	-16.14	M
10/20-16:44	455	$GPGGA	224358	4939.55873	N	11248.469352	W	1	7	2.1	913.574	M	-16.14	M
10/20-16:45	456	$GPGGA	224458	4939.55826	N	11248.469782	W	2	7	2.3	913.803	M	-16.14	M
10/20-16:46	457	$GPGGA	224558	4939.55855	N	11248.470141	W	2	7	2.1	906.469	M	-16.14	M
10/20-16:47	458	$GPGGA	224658	4939.55880	N	11248.470377	W	2	7	2.2	906.128	M	-16.14	M

Table 4: *Circle_calc.xls* spreadsheet to convert GPS data to degrees of pivot rotation.

latitude (degree-min)	longitude (degree-min)	altitude (metres)	latitude (degrees)	longitude (degrees)	latitude (m)	longitude (m)	x (m)	y (m)	(degrees)
4939.55875	11248.469532	913.447	49.6593	112.8078	5523357.03	8027968.90	209.01	-179.42	58.5
4939.55873	11248.469352	913.574	49.6593	112.8078	5523356.99	8027968.69	208.97	-179.63	58.5
4939.55826	11248.469782	913.803	49.6593	112.8078	5523356.12	8027969.20	208.09	-179.12	58.7
4939.55855	11248.470141	906.469	49.6593	112.8078	5523356.66	8027969.63	208.64	-178.69	58.6
4939.55880	11248.470377	906.128	49.6593	112.8078	5523357.13	8027969.91	209.10	-178.41	58.5

Speed sensor

The speed sensor will be an optical sensor that will be connected directly to the CR1000 data logger P1 (pulse) channel.

Wireless radios

Phoenix Contact 900 MHz radios will be used to transfer the signal from the pressure transducers on the center pivot and the GPS receivers to the data logger located at the pump site.

Variable Frequency Drive (VFD)

The VFD will be a Cutler-Hammer model SVX9000 supplied and connected by Rivers Electric.

APPENDIX A
SENSORS and EQUIPMENT

Pressure transducers:

Wired:

1. pump inlet (centrifugal pump)
   Manufacturer: Cole Parmer Instruments
   Model: 68075-32 (24vdc) – 0.5-5.5 VDC; -14.7-15 psig
   Serial #: 3109-4005395
   Supplier: : Cole Palmer Instruments

2. pump discharge
   Manufacturer: SSI Technologies Inc.
   Model: P51-100-G-A-I36-5V-R
   Serial #: 090973017 and 0909763403
   Supplier:

Wireless

3. pivot point, last tower and corner arm
   Manufacturer: SSI Technologies Inc.
   Model: P51-100-G-A-I36-20ma
   Serial #: 110102583, 11012605, 110102611, 11012643, 090763654, 090763664
   Supplier:

Flow meter:

1. Manufacturer: GE Panametrics
   Model: PT878
   Supplier: Procon Systems Inc, Calgary

2. Manufacturer: McCrometer Inc.
   Model: McPropeller M0310
   Accessories: FS100 flow straightener, EA631 pulse transmitter
   Supplier: Conona Electric, Lethbridge

Power meter:

Manufacturer: Accuenergy
Model: Acuvim II
Supplier: Optimum Energy, Calgary

GPS:

Manufacturer: John Deere
Model: StarFire iTC
Supplier: Western Tractor, Lethbridge

900 MHz transmitter/receiver – Pressure sensors:

Manufacturer: Phoenix Contact
Model: RAD-ISM-900-TX/RX-DC
Serial #: 97294146, 97294078, 97294191

ID: 14663, 15425, 15437
Supplier: Phoenix Contact Canada, Milton, Ontario

900 MHz transmitter/receiver – GPS:
Manufacturer: Phoenix Contact
Model: RAD-ISM-RS232-BD
Serial #:
ID:
Supplier: Phoenix Contact Canada, Milton, Ontario

Data logger:
Manufacturer: Campbell Scientific
Model: CR1000
Supplier: Campbell Scientific Canada, Edmonton

RS485 to RS232 adapter:
Manufacturer: BlackBox
Model: IC820A
Supplier: BlackBox Canada

VFD:
Manufacturer: Cutler-Hammer
Model: SVX9000
Supplier: Rivers Electric, Taber

APPENDIX B
Power meter CRBasic test programs

Program to test for all 35 power parameters

```
'Program to test for data from the Acuvim II power meter to CR1000.
'CR1000 OS22 required.
'Written by: Gregg Dill; Nov 22, 2011
''Requires CR800 OS v.3, CR1000 OS v.12, or CR3000 OS v.5 or higher
'CR1000 uses Big-endien word order.
'Declarations
Public Register(35),BatVolts,PanelTempC
'variables
Public Result   'Holds the result of the ModBus master query
'Aliases used for clarification
'Once an alias is assigned, the original variable is not available.
'Alias Register(1) = V_AN
'Alias Register(2) = V_BN
DataTable (Table,True,-1)
  DataInterval (0,5,Sec,10)
  Sample (1,BatVolts,FP2)
  Sample (1,PanelTempC,FP2)
  'Result must be a constant value (either + or -).
  'If it is incrementing, there is no communication.
  Sample (1,Result,FP2)
  'Register data parameters are in the order they are displayed
  'on the Acuvim real-time Metering screen.
  'The first data available is register 4002H (16386 Dec). H=Hex
  'Exception: Frequency is not displayed and does not exist in register 4000H.
  Sample (35,Register(),IEEE4)
EndTable

BeginProg
  SerialOpen (Com1,38400,3,0,250)

  Scan(5,Sec,0,0)
    Battery (BatVolts)
    PanelTemp (PanelTempC,250)
    'Collect data from AcuvimII starting at register  4002H (16386).
     ModBusMaster(Result,Com1,38400,1,3,Register(),16386,35,3,100,0)

    CallTable Table
  NextScan

EndProg
```

Program to test for communication using ComRS232 and theCR100KD display/keyboard

```
'Program to test data from AcuvimII using ComRS232 port and CR1000KD display.
'Require a null modem cable from AcuvimII to CR1000.
'Requires CR800 OS v.3, CR1000 OS v.12, or CR3000 OS v.5 or higher
'CR1000 uses Big-endien word order.
'Declarations
Public Register(10),BatVolts,PanelTempC
'variables
Public Result 'Holds the result of the ModBus master
'query
'Aliases used for clarification
'Alias Register(1) = V_AN
'Alias Register(2) = V_BN
DataTable (Table,True,-1)
  DataInterval (0,5,Sec,10)
  Sample (1,BatVolts,FP2)
  Sample (1,PanelTempC,FP2)
  Sample (1,Result,FP2)
  Sample (2,Register(),IEEE4)
EndTable

BeginProg
  SerialOpen (ComRS232,38400,3,0,250)

  Scan(5,Sec,0,0)
   Battery (BatVolts)
   PanelTemp (PanelTempC,250)
    ModBusMaster(Result,ComRS232,38400,1,3,Register(),16386,2,3,100,0)

    CallTable Table
  NextScan

EndProg
```

APPENDIX C
GPS CRBasic test program

Program to verify the parameters provided by the StarFire2 NMEA gga data string.

```
'CR1000 Series Datalogger
'To create a different opening program template, type in new
'instructions and select Template | Save as Default Template
'date: 3 October 2011
'program author: Gregg Dill

Public rawdata As String * 500
'gga variables
Public ggaid As String
Public ggautc As String
Public ggalatitude As String
Public ggan_s_ind As String
Public ggalongitude As String
Public ggae_w_ind As String
Public ggapositionfix As String
Public gganumsatellites As String
Public ggahdop As String
Public ggaaltitude As String
Public ggaaltutudeunits As String
Public ggageoidsep As String
Public ggageoidunits As String
Public ggaage As String
Public ggarefstationID As String
DataTable (gpsdata,True,-1)
  DataInterval (0,1,min,10)
  Sample (1,ggaid,String)
  Sample (1,ggautc,String)
  Sample (1,ggalatitude,String)
  Sample (1,ggan_s_ind,String)
  Sample (1,ggalongitude,String)
  Sample (1,ggae_w_ind,String)
  Sample (1,ggapositionfix,String)
  Sample (1,gganumsatellites,String)
  Sample (1,ggahdop,String)
  Sample (1,ggaaltitude,String)
  Sample (1,ggaaltutudeunits,String)
  Sample (1,ggageoidsep,String)
  Sample (1,ggageoidunits,String)
'  Sample (1,ggaage,String)
'  Sample (1,ggarefstationID,String)
EndTable

'Main Program
```

```
BeginProg
  Scan (1,Sec,0,0)
    SerialOpen (Com1,38400,0,0,500)
    SerialInBlock (Com1,rawdata,500)
    'parse gga data
    ggaid=Mid (rawdata,1,6)
    ggautc=Mid (rawdata,8,8)
    ggalatitude=Mid (rawdata,17,11)
    ggan_s_ind=Mid (rawdata,29,1)
    ggalongitude=Mid (rawdata,31,12)
    ggae_w_ind=Mid (rawdata,44,1)
    ggapositionfix=Mid (rawdata,46,1)
    gganumsatellites=Mid (rawdata,48,2)
    ggahdop=Mid (rawdata,50,3)
    ggaaltitude=Mid (rawdata,54,7)
    ggaaltutudeunits=Mid (rawdata,62,1)
    ggageoidsep=Mid (rawdata,64,7)
    ggageoidunits=Mid (rawdata,72,1)
'    ggaage=Mid (rawdata,60,3)
'    ggarefstationID=Mid (rawdata,75,6)
    CallTable gpsdata
  NextScan
EndProg
```

APPENDIX D
Instrumentation Specifications and brochures

Brochures included:

1. Campbell Scientific data logger
2. Acuvim II power meter
3. Hawkeye current transformer
4. McPropeller flow meter
5. McSpaceSaver flow straightener
6. GE Panametrics PT878 flow meter
7. John Deere StarFire iTC GPS
8. SSI Pressure transducer
9. Cole Parmer pressure transducer
10. Phoenix Contact 900 MHz receiver
11. Phoenix Contact 900 MHz transmitter
12. Phoenix Contact 900 MHz RS232 radio
13. BlackBox RS485-RS232 converter
14. Cutler-Hammer SVX9000 VFD

CAMPBELL SCIENTIFIC®

WHEN MEASUREMENTS MATTER

CR1000

measurement & control datalogger

A rugged instrument with research-grade performance.

CR1000 Measurement and Control System

The CR1000 provides precision measurement capabilities in a rugged, battery-operated package. It consists of a measurement and control module and a wiring panel. Standard operating range is -25° to +50°C; an optional extended range of -55° to +85°C is available.

Input/Output Terminals—Individually configured for ratiometric resistive bridge, thermocouple, switch closure, high frequency pulse, low-level ac, serial sensors, and more.

Removable Power Terminal—simplifies connection to external power supply.

RS-232—provides a 9-pin DCE port for connecting a battery-powered laptop, serial sensors or RS-232 modems.

CS I/O Port—connects with AC-powered PCs and communication peripherals such as phone, RF, short-haul, and multidrop modems.

Peripheral Port—allows data to be stored on a CompactFlash card and/or supports Ethernet communications.

Features

- 4 Mbyte memory*
- Program execution rate of up to 100 Hz
- CS I/O and RS-232 serial ports
- 13-bit analog to digital conversions
- 16-bit H8S Renesas Microcontroller with 32-bit internal CPU architecture
- Temperature compensated real-time clock
- Background system calibration for accurate measurements over time and temperature changes
- Single DAC used for excitation and measurements to give ratio metric measurements
- Gas Discharge Tube (GDT) protected inputs
- Data values stored in tables with a time stamp and record number
- Battery-backed SRAM memory and clock ensuring data, programs, and accurate time are maintained while the CR1000 is disconnected from its main power source
- Serial communications with serial sensors and devices supported via I/O port pairs
- PakBus®, Modbus, DNP3, TCP/IP, FTP, and SMTP protocols supported

Measurement and Control Module

The module measures sensors, drives direct communications and telecommunications, reduces data, controls external devices, and stores data and programs in on-board, non-volatile storage. The electronics are RF shielded and glitch protected by the sealed, stainless steel canister. A battery-backed clock assures accurate timekeeping. The module can simultaneously provide measurement and communication functions. The on-board, BASIC-like programming language supports data processing and analysis routines.

Wiring Panel

The CR1000WP is a black, anodized aluminum wiring panel that is compatible with all CR1000 modules. The wiring panel includes switchable 12 V, redistributed analog grounds (dispersed among analog channels rather than grouped), unpluggable terminal block for 12 V connections, gas-tube spark gaps, and 12 V supply on pin 8 to power our COM-series phone modems and other peripherals. The control module easily disconnects from the wiring panel allowing field replacement without rewiring the sensors. A description of the wiring panel's input/output channels follows.

**Originally, the standard CR1000 had 2 MB of data/program storage, and an optional version, the CR1000-4M, had 4 MB of memory. In September 2007, the standard CR1000 started having 4 MB of memory, making the CR1000-4M obsolete. Dataloggers that have a module with a serial number greater than or equal to 11832 will have a 4 MB memory. The 4 MB dataloggers will also have a sticker on the canister stating "4M Memory".*

Analog Inputs
Eight differential (16 single-ended) channels measure voltage levels. Resolution on the most sensitive range is 0.67 µV.

Pulse Counters
Two pulse channels can count pulses from high level (5 V square wave), switch closure, or low level AC signals.

Switched Voltage Excitations
Three outputs provide precision excitation voltages for resistive bridge measurements.

Digital I/O Ports
Eight ports are provided for frequency measurements, digital control, and triggering. Three of these ports can also be used to measure SDM devices. The I/O ports can be paired as transmit and receive. Each pair has 0 to 5 V UART hardware that allows serial communications with serial sensors and devices. An RS232-to-logic level converter may be required in some cases.

CS I/O Port
AC-powered PCs and many communication peripherals connect with the CR1000 via this port. Connection to an AC-powered PC requires either an SC32B or SC-USB interface. These interfaces isolate the PC's electrical system from the datalogger, thereby protecting against ground loops, normal static discharge, and noise.

RS-232 Port
This non-isolated port is for connecting a battery-powered laptop, serial sensor, or RS-232 modem. Because of ground loop potential on some measurements (e.g., low level single-ended measurements), AC-powered PCs should use the CS I/O port instead of the RS-232 port (see above).

Peripheral Port
One 40-pin port interfaces with the NL115 Ethernet Interface & CompactFlash Module, the NL120 Ethernet Interface, or the CFM100 CompactFlash® Module.

Switched 12 Volt
This terminal provides unregulated 12 V that can be switched on and off under program control.

Storage Capacity
The CR1000 has 2 MB of flash memory for the Operating System, and 4 MB of battery-backed SRAM for CPU usage, program storage, and data storage. Data is stored in a table format. The storage capacity of the CR1000 can be increased by using a CompactFlash card.

Communication Protocols
The CR1000 supports the PakBus, Modbus, DNP3, TCP/IP, FTP, and SMTP communication protocols. With the PakBus protocol, networks have the distributed routing intelligence to continually evaluate links. Continually evaluating links optimizes delivery times and, in the case of delivery failure, allows automatic switch over to a configured backup route.

The Modbus RTU protocol supports both floating point and long formats. The datalogger can act as a slave and/or master.

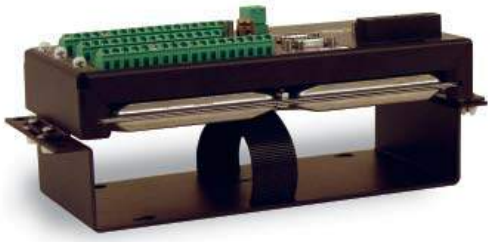
The DNP3 protocol supports only long data formats. The dataloggers are level 2 slave compliant, with some of the operations found in a level 3 implementation.

The TCP/IP, FTP, and SMTP protocols provide TCP/IP functionality when the CR1000 is used in conjunction with an NL115, NL120, or third party serial IP device. Refer to the CR1000 manual for more information.

Power Supplies
Any 12 Vdc source can power the CR1000; a PS100 or BPALK is typically used. The PS100 provides a 7-Ahr sealed rechargeable battery that should be connected to a charging source (either a wall charger or solar panel). The BPALK consists of eight non-rechargeable D-cell alkaline batteries with a 7.5-Ahr rating at 20°C.

Also available are the BP12 and BP24 battery packs, which provide nominal ratings of 12 and 24 Ahrs, respectively. These batteries should be connected to a regulated charging source (e.g., a CH100 connected to a unregulated solar panel or wall charger).

Enclosure/Stack Bracket
A CR1000 housed in a weather-resistant enclosure can collect data under extremely harsh conditions. The 17565 Stack Bracket allows a small peripheral to be placed under the mounting bracket, thus conserving space. With the bracket, the CR1000 can be attached in a "horizontal" orientation in an ENC10/12 enclosure (i.e., the long axis of the CR1000 spanning the short axis of the enclosure).



Above is a CR1000 mounted to the stack bracket. The Velcro strap is for fastening a peripheral to the base of the bracket.

Data Storage and Retrieval Options

To determine the best option for an application, consider the accessibility of the site, availability of services (e.g., cellular phone or satellite coverage), quantity of data to collect, and desired time between data-collection sessions. Some communication options can be combined—increasing the flexibility, convenience, and reliability of the communications.

Keyboard Display

The CR1000KD can be used to program the CR1000, manually initiate data transfer, and display data. The CR1000KD displays 8 lines x 21 characters (64 x 128 pixels) and has a 16-character keyboard. Custom menus are supported allowing customers to set up choices within the datalogger program that can be initiated by a simple "toggle" or "pick list".

One CR1000KD can be carried from station to station in a CR1000 network.

Portable Handheld Devices

An Archer-PCon or user-supplied PDA can be used to collect and display the CR1000's data, transfer datalogger programs, graph data for up to two elements, and transfer the datalogger's data to a PC. User-supplied PDAs require either PConnect or PConnectCE software.

Direct Links

AC-powered PCs connect with the datalogger's CS I/O port via an SC32B or SC-USB interface. These interfaces provide optical isolation. A battery-powered laptop can be attached to the CR1000's RS-232 port via an RS-232 cable—no interface required.

External Data Storage Devices

A CFM100 or NL115 module can store the CR1000's data on an industrial-grade CompactFlash (CF) card (2 GB or less). The PC reads the CF card using either the CF1 CompactFlash Adapter or a 17752 USB Reader/Writer. The CR1000 can also store data on an SC115 2-GB Flash Memory Drive.

Mountable Displays

The CD100 and CD295 can be mounted in an enclosure lid. The CD100 has the same functionality and operation as the CD1000KD, allowing both data entry and display without opening the enclosure. The CD295 displays real-time data only.

Short Haul Modems

The SRM-5A RAD Short Haul Modem supports communications between the CR1000 and a PC via a four-wire unconditioned line (two twisted pairs).

Multidrop Interface

The MD485 intelligent RS-485 interface permits a PC to address and communicate with one or more dataloggers over the CABLE2TP two-twisted pair cable. Distances up to 4000 feet are supported.

Ethernet

Use of an NL200, NL120, NL115, or NL100 interface enables the CR1000 to communicate over a local network or a dedicated Internet connection via TCP/IP. The NL115 can also store data on a CompactFlash card.

Radios

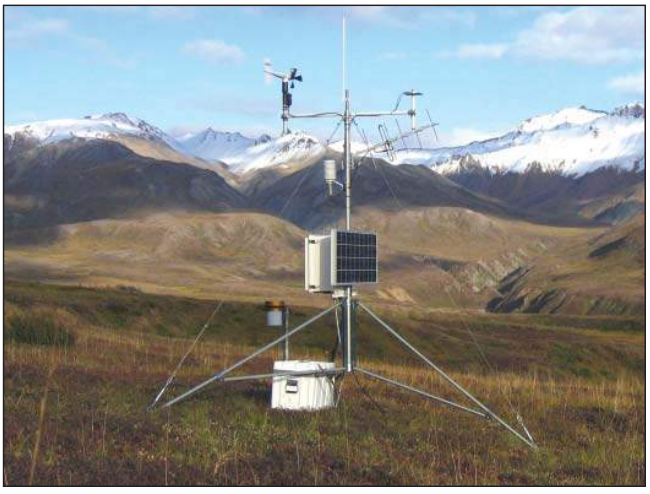
Radio frequency (RF) communications are supported via narrow-band UHF, narrow-band VHF, spread spectrum, or meteor burst radios. Line-of-sight is required for all of our RF options.

Telephone Networks

The CR1000 can communicate with a PC using landlines, cellular CDMA, or cellular GPRS transceivers. A voice synthesized modem enables anyone to call the CR1000 via phone and receive a verbal report of real-time site conditions.

Satellite Transmitters

Our NESDIS-certified GOES satellite transmitter provides one-way communications from a Data Collection Platform (DCP) to a receiving station. We also offer an Argos transmitter that is ideal for high-altitude and polar applications.



This weather station at Denali National Park, Alaska, transmits data via a GOES satellite transmitter.

Channel Expansion

4-Channel Low Level AC Module

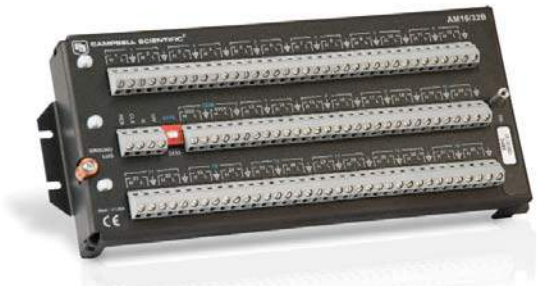
The LLAC4 is a small peripheral device that allows customers to increase the number of available low-level ac inputs by using control ports. This module is often used to measure up to four anemometers, and is especially useful for wind profiling applications.

Synchronous Devices for Measurement (SDMs)

SDMs are addressable peripherals that expand the datalogger's measurement and control capabilities. For example, SDMs are available to add control ports, analog outputs, pulse count channels, interval timers, or even a CANbus interface to the system. Multiple SDMs, in any combination, can be connected to one datalogger.

Multiplexers

Multiplexers increase the number of sensors that can be measured by a CR1000 by sequentially connecting each sensor to the datalogger. Several multiplexers can be controlled by a single CR1000.



The CR1000 is compatible with the AM16/32B (shown above) and AM25T multiplexers.

Software

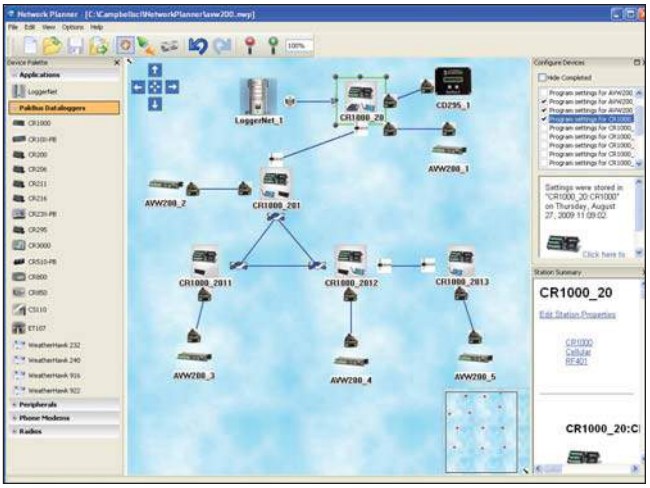
Starter Software

Our easy-to-use starter software is intended for first time users or applications that don't require sophisticated communications or datalogger program editing. SCWin Short Cut generates straight-forward CR1000 programs in four easy steps. PC200W allows customers to transfer a program to, or retrieve data from a CR1000 via a direct communications link.

At www.campbellsci.com/downloads you can download starter software at no charge. Our Resource CD also provides this software as well as PDF versions of our brochures and manuals.

Datalogger Support Software

Our datalogger support software packages provide more capabilities than our starter software. These software packages contains program editing, communications, and display tools that can support an entire datalogger network.

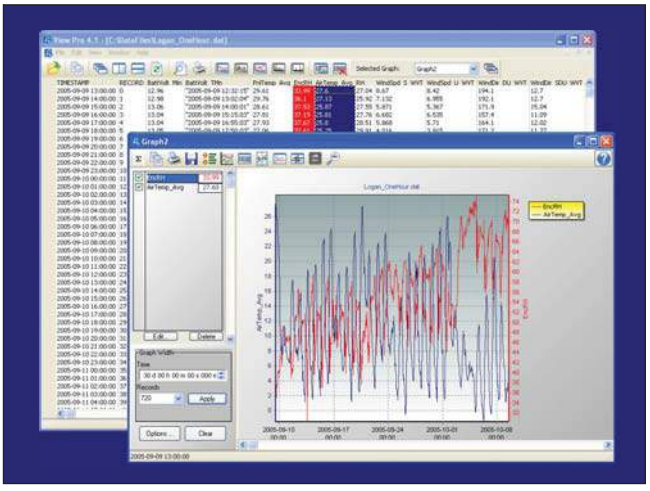


The Network Planner, included in LoggerNet 4 or higher, generates device settings and configures the LoggerNet network map for PakBus networks.

PC400, our mid-level software, supports a variety of telemetry options, manual data collection, and data display. For programming, it includes both Short Cut and the CRBasic program editor. PC400 does not support combined communication options (e.g., phone-to-RF), PakBus® routing, or scheduled data collection.

RTDAQ is an ideal solution for industrial and real-time users desiring to use reliable data collection software over a single telecommunications medium, and who do not rely on scheduled data collection. RTDAQ's strength lies in its ability to handle the display of high speed data.

LoggerNet is Campbell Scientific's full-featured datalogger support software. It is referred to as "full-featured" because it provides a way to accomplish almost all the tasks you'll need to complete when using a datalogger. LoggerNet supports combined communication options (e.g., phone-to-RF) and scheduled data collection.



Both LoggerNet and RTDAQ use View Pro to display historical data in a tabular or graphical format.

Applications

The measurement precision, flexibility, long-term reliability, and economical price of the CR1000 make it ideal for scientific, commercial, and industrial applications.

Meteorology

The CR1000 is used in long-term climatological monitoring, meteorological research, and routine weather measurement applications.

Our rugged, reliable weather station measures meteorological conditions at St. Mary's Lake, Glacier National Park, MT.

Sensors the CR1000 can measure include:

- cup, propeller, and sonic anemometers
- tipping bucket rain gages
- wind vanes
- pyranometers
- ultrasonic ranging sensor
- thermistors, RTDs, and thermocouples
- barometric pressure sensors
- RH sensors
- cooled mirror hygrometers

Agriculture and Agricultural Research

The versatility of the CR1000 allows measurement of agricultural processes and equipment in applications such as:

- plant water research
- canopy energy balance
- machinery performance
- plant pathology
- crop management decisions
- food processing/storage
- frost prediction
- irrigation scheduling
- integrated pest management

This vitaculture site in Australia integrates meteorological, soil, and crop measurements.

Wind Profiling

Our data acquisition systems can monitor conditions at wind assessment sites, at producing wind farms, and along transmission lines. The CR1000 makes and records measurements, controls electrical devices, and can function as PLCs or RTUs. Because the datalogger has its own power supply (batteries, solar panels), it can continue to measure and store data and perform control during power outages.

Typical sensors for wind assessment applications include, but are not limited to:

- sonic anemometers
- three-cup and propeller anemometers (up to 10 anemometers can be measured by using two LLAC4 peripherals)
- wind vanes
- temperature sensors
- barometric pressure
- wetness
- solar radiation

Photo courtesy npower renewables

A Campbell Scientific system monitors an offshore wind farm in North Wales.

For turbine performance applications, the CR1000 monitors electrical current, voltage, wattage, stress, and torque.

Soil Moisture

The CR1000 is compatible with the following soil moisture measurement technologies:

- Soil moisture blocks are inexpensive sensors that estimate soil water potential.
- Matric water potential sensors also estimate soil water potential but are more durable than soil moisture blocks.
- Time-Domain Reflectometry Systems (TDR) use a reflectometer controlled by a CR1000 to accurately measure soil water content. Multiplexers allow sequential measurement of a large number of probes by one reflectometer, reducing cost per measurement.
- Self-contained water content reflectometers are sensors that emit and measure a TDR pulse.
- Tensiometers measure the soil pore pressure of irrigated soils and calculate soil moisture.

Air Quality

The CR1000 can monitor and control gas analyzers, particle samplers, and visibility sensors. It can also automatically control calibration sequences and compute conditional averages that exclude invalid data (e.g., data recorded during power failures or calibration intervals).

Road Weather/RWIS

Our fully NTCIP-compliant Environmental Sensor Stations (ESS) are robust, reliable weather stations used for road weather/RWIS applications. A typical ESS includes a tower, CR1000, two road sensors, remote communication hardware, and sensors that measure wind speed and direction, air temperature, humidity, barometric pressure, solar radiation, and precipitation.

Water Resources/Aquaculture

Our CR1000 is well-suited to remote, unattended monitoring of hydrologic conditions. Most hydrologic sensors, including SDI-12 probes, interface directly to the CR1000. Typical hydrologic measurements:

- **Water level** is monitored with incremental shaft encoders, double bubblers, ultrasonic ranging sensors, resistance tapes, strain gage pressure transducers, or vibrating wire pressure transducers. Vibrating wire transducers require an AVW200-series or another vibrating wire interface.
- **Ionic conductivity** measurements use one of the switched excitation ports from the CR1000.
- **Samplers** are controlled by the CR1000 as a function of time, water quality, or water level.
- **Alarm and pump actuation** are controlled through digital I/O ports that operate external relay drivers.

A turbidity sensor was installed in a tributary of the Cedar River watershed to monitor water quality conditions for the city of Seattle, Washington.

Vehicle Testing

This versatile, rugged datalogger is ideally suited for testing cold and hot temperature, high altitude, off-highway, and cross-country performance. The CR1000 is compatible with our SDM-CAN interface and GPS16X-HVS receiver.

Vehicle monitoring includes not only passenger cars, but airplanes, locomotives, helicopters, tractors, buses, heavy trucks, drilling rigs, race cars, and motorcycles.

The CR1000 can measure:

- **Suspension**—strut pressure, spring force, travel, mounting point stress, deflection, ride
- **Fuel system**—line and tank pressure, flow, temperature, injection timing
- **Comfort control**— fan speed, ambient and supply air temperature, refrigerant pressures, solar radiation, ac on and off, time-to-comfort, blower current
- **Brakes**—line pressure, pedal pressure and travel, ABS, line and pad temperature
- **Engine**—pressure, temperature, crank position, RPM, time-to-start, oil pump cavitation
- **General vehicle**—chassis monitoring, road noise, vehicle position and speed, steering, air bag, hot/cold soaks, wind tunnels, traction, CANbus, wiper speed and current, vehicle electrical loads

Other Applications

- Eddy covariance systems
- Wireless sensor/datalogger networks
- Mesonet systems
- Avalanche forecasting, snow science, polar, high altitude
- Fire weather
- Geotechnical
- Historic preservation

CR1000 Specifications

Electrical specifications are valid over a -25° to +50°C range unless otherwise specified; non-condensing environment required. To maintain electrical specifications, Campbell Scientific recommends recalibrating dataloggers every two years. We recommend that the system configuration and critical specifications are confirmed with Campbell Scientific before purchase.

PROGRAM EXECUTION RATE

10 ms to one day @ 10 ms increments

ANALOG INPUTS (SE1-SE16 or DIFF1-DIFF8)

8 differential (DF) or 16 single-ended (SE) individually configured. Channel expansion provided by AM16/32B and AM25T multiplexers.

RANGES and RESOLUTION: Basic resolution (Basic Res) is the A/D resolution of a single conversion. Resolution of DF measurements with input reversal is half the Basic Res.

Range (mV)[1]	*DF Res (µV)* [2]	*Basic Res (µV)*
±5000	667	1333
±2500	333	667
±250	33.3	66.7
±25	3.33	6.7
±7.5	1.0	2.0
±2.5	0.33	0.67

[1]Range overhead of ~9% on all ranges guarantees that full-scale values will not cause over range.

[2]Resolution of DF measurements with input reversal.

ACCURACY[3]:
±(0.06% of reading + offset), 0° to 40°C
±(0.12% of reading + offset), -25° to 50°C
±(0.18% of reading + offset), -55° to 85°C (-XT only)

[3]Accuracy does not include the sensor and measurement noise. The offsets are defined as:
Offset for DF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±2.5 mV input range; digital resolution dominates for higher ranges.

250 µs Integration: 0.34 µV RMS
50/60 Hz Integration: 0.19 µV RMS

ANALOG MEASUREMENT SPEED:

Integration Type/ Code	*Integration Time*	*Settling Time*	*Total Time*[5] *SE w/ No Rev*	*Total Time*[5] *DF w/ Input Rev*
250	250 µs	450 µs	~1 ms	~12 ms
60 Hz[4]	16.67 ms	3 ms	~20 ms	~40 ms
50 Hz[4]	20.00 ms	3 ms	~25 ms	~50 ms

[4]AC line noise filter.

[5]Includes 250 µs for conversion to engineering units.

INPUT LIMITS: ±5 V

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±90 nA @ 85°C

INPUT RESISTANCE: 20 Gohms typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):
±0.3°C, -25° to 50°C
±0.8°C, -55° to 85°C (-XT only)

ANALOG OUTPUTS (Vx1-Vx3)

3 switched voltage, active only during measurement, one at a time.

RANGE AND RESOLUTION: Voltage outputs programmable between ±2.5 V with 0.67 mV resolution.

V_x ACCURACY: ±(0.06% of setting + 0.8 mV), 0° to 40°C
±(0.12% of setting + 0.8 mV), -25° to 50°C
±(0.18% of setting + 0.8 mV), -55° to 85°C (-XT only)

V_x FREQUENCY SWEEP FUNCTION: Switched outputs provide a programmable swept frequency, 0 to 2500 mv square waves for exciting vibrating wire transducers.

CURRENT SOURCING/SINKING: ±25 mA

RESISTANCE MEASUREMENTS

MEASUREMENT TYPES: The CR1000 provides ratiometric measurements of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Precise, dual polarity excitation using any of the 3 switched voltage excitations eliminates dc errors.

VOLTAGE RATIO ACCURACY[6]: Assuming excitation voltage of at least 1000 mV, not including bridge resistor error.

±(0.04% of voltage reading + offset)/V_x

[6]Accuracy does not include the sensor and measurement noise. The offsets are defined as:
Offset for DF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

Offset values are reduced by a factor of 2 when excitation reversal is used.

PERIOD AVERAGE

Any of the16 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading + resolution), where resolution is 136 ns divided by the specified number of cycles to be measured.

INPUT AMPLITUDE AND FREQUENCY:

Voltage Gain	*Input Range (±mV)*	*Signal (peak to peak)*[7] *Min. (mV)*	*Signal (peak to peak)*[7] *Max (V)*	*Min Pulse Width (µV)*	*Max*[8] *Freq (kHz)*
1	2500	500	10	2.5	200
10	250	10	2	10	50
33	25	5	2	62	8
100	2.5	2	2	100	5

[7]With signal centered at the datalogger ground.

[8]The maximum frequency = 1/(Twice Minimum Pulse Width) for 50% of duty cycle signals.

PULSE COUNTERS (P1-P2)

(2) inputs individually selectable for switch closure, high frequency pulse, or low-level ac. Independent 24-bit counters for each input.

MAXIMUM COUNTS PER SCAN: 16.7×10^6

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH-FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW-LEVEL AC MODE: Internal AC coupling removes AC offsets up to ±0.5 V.
Input Hysteresis: 12 mV @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

Sine Wave (mV RMS)	*Range(Hz)*
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

DIGITAL I/O PORTS (C1-C8)

8 ports software selectable, as binary inputs or control outputs. Also provide edge timing, subroutine interrupts/wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UART), SDI-12 communications, and SDM communications.

HIGH-FREQUENCY MAX: 400 kHz

SWITCH CLOSURE FREQUENCY MAX: 150 Hz

EDGE TIMING RESOLUTION: 540 ns

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 ohms

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 kohms

SWITCHED 12 V (SW-12)

One independent 12 V unregulated sources switched on and off under program control. Thermal fuse hold current = 900 mA @ 20°C, 650 mA @ 50°C, 360 mA @ 85°C.

CE COMPLIANCE

STANDARD(S) TO WHICH CONFORMITY IS DECLARED: IEC61326:2002

COMMUNICATIONS

RS-232 PORTS:
9-pin: DCE port for battery-powered computer or non-CSI modem connection.
COM1 to COM4: Four independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 VUART
Baud Rates: selectable from 300 bps to 115.2 kbps.
Default Format: 8 data bits; 1 stop bits; no parity
Optional Formats: 7 data bits; 2 stop bits; odd, even parity

CS I/O PORT: Interface with CSI peripherals

SDI-12: Digital control ports 1, 3, 5, and 7 are individually configured and meet SDI-12 Standard version 1.3 for datalogger mode. Up to ten SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals

PROTOCOLS SUPPORTED: PakBus, Modbus, DNP3, FTP, HTTP, XML, POP3, SMTP, Telnet, NTCIP, NTP, SDI-12, SDM

CPU AND INTERFACE

PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core)

MEMORY: 2 MB of Flash for operating system; 4 MB of battery-backed SRAM for CPU usage, program storage and data storage.

CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional.

SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 16 Vdc (reverse polarity protected)

EXTERNAL BATTERIES: 12 Vdc nominal

TYPICAL CURRENT DRAIN:
Sleep Mode: 0.7 mA (0.9 mA max.)
1 Hz Sample Rate (1 fast SE meas.): 1 mA
100 Hz Sample Rate (1 fast SE meas.): 16.2 mA
100 Hz Sample Rate (1 fast SE meas. w/RS-232 communication): 27.6 mA
Optional Keyboard Display On (no backlight): add 7 mA to current drain
Optional Keyboard Display On (backlight on): add 100 mA to current drain

PHYSICAL

DIMENSIONS: 9.4" x 4" x 2.4" (23.9 x 10.2 x 6.1 cm); additional clearance required for serial cable and sensor leads.

WEIGHT: 2.1 lbs (1 kg)

WARRANTY

3-years against defects in materials and workmanship.

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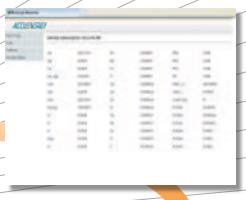
Printed November 2011

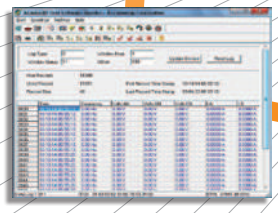
Acuvim II Series
Intelligent Power Meter
(Web Accessible)

Revenue Grade with DATA-LOGGING

Email



Real Time Metering



Data-Logging

Max & Min Record

TOU

ISO9001 Certified

ACCUENERGY

DESCRIPTION

The Acuvim II is a high-end multifunction power meter manufactured by Accuenergy. It is the ideal choice for monitoring and controlling of power distribution systems. Some of the features and electric power parameters available on the compact Acuvim II are:

- True-RMS Measuring Parameter
- ANSI C12.20(0.2 Class) and IEC 62053-22(0.2S Class)
- Power Quality Analysis
- Over/Under Limit Alarm
- Multi Communication Ports (Eg: Ethernet, RS485)
- Web Server and Email Sending
- Switch Status Monitoring
- Remote Switch Controlling
- Measure Individual Harmonics from 2nd to 63rd(Acuvim IIR,Acuvim IIE)
- Module Design
- Data-Logging
- TOU, 4 Tariffs, 12 Seasons, 14 Schedules

Acuvim II may be used as a data gathering device for an intelligent Power Distribution System or Plant Automation System. All monitored data is available via a digital RS485 communication port running Modbus®-RTU Protocol. Ethernet and Profibus DP communication are also options and with new wireless technologies and protocols currently under development, the applications for the Acuvim II meter are limitless.

Acuvim II Series Meter

● Function; ⊙ Option; Blank NA

CATEGORY		ITEM	PARAMETERS	Acuvim II	Acuvim IIR	Acuvim IIE
METERING	REAL TIME METERING	Phase Voltage	V1, V2, V3, Vlnavg	●	●	●
		Line Voltage	V12, V23, V31, Vllavg	●	●	●
		Current	I1, I2, I3, In, Iavg	●	●	●
		Power	P1, P2, P3, Psum	●	●	●
		Reactive Power	Q1, Q2, Q3, Qsum	●	●	●
		Apparent Power	S1, S2, S3, Ssum	●	●	●
		Power Factor	PF1, PF2, PF3, PF	●	●	●
		Frequency	F	●	●	●
		Load Features	Load Features	●	●	●
		Four Quadrant Powers	Four Quadrant Powers	●	●	●
	ENERGY & DEMAND	Energy	Ep_imp, Ep_exp, Ep_total, Ep_net	●	●	●
		Reactive Energy	Eq_imp, Eq_exp, Eq_total, Eq_net	●	●	●
		Apparent Energy	Es	●	●	●
		Demand	Dmd_P, Dmd_Q, Dmd_S, Dmd_I1, Dmd_I2, Dmd_I3	●	●	●
TOU	TIME OF USE	Energy/max demand	TOU, 4 Tariffs, 12 Seasons, 14 Schedules			●
	DAYLIGHT SAVING TIME	Two formats adjust	Month/Day/Hour/Minute Month/Week/First few weeks/Hour/Minute			●
MONITORING	POWER QUALITY	Voltage Unbalance Factor	U_unbl	●	●	●
		Current Unbalance Factor	I_unbl	●	●	●
		Voltage THD	THD_V1,THD_V2,THD_V3, THD_Vavg	●	●	●
		Current THD	THD_I1, THD_I2, THD_I, THD_Iavg	●	●	●
		Individual Harmonics	Harmonics 2nd to 31st (63rd for Acuvim IIR, Acuvim IIE)	●	●	●
		Voltage Crest Factor	Crest Factor	●	●	●
		TIF	THFF	●	●	●
		Current K factor	K Factor	●	●	●
	STATISTICS	MAX with Time Stamp MIN with Time Stamp	Each phase of V & I;Total of P, Q, S, PF & F;Demad of P,Q & S;Each phase THD of V & I;Unbalnce factor of V & I	●	●	●
OTHERS	ALARM	Over/Under Limit Alarm	V,I,P,Q,S,PF,V_THD & I_THD each phase and total or average; Unbalance factor of V & I;load type;Analog Input of each channel	●	●	●
	DATA LOGGING	Data Logging 1 Data Logging 2 Data Logging 3	F, V1/2/3/Inavg, V12/23/13/Iavg, I1/2/3/n/avg, P1/2/3/sum, Q1/2/3/sum, S1/2/3/sum, PF1/2/3, PF, U_unbl, I_unbl, Load Type, Ep_imp, Ep_exp, Ep_total, Ep_net, Eq_imp, Eq_exp, Eq_total, Eq_net, Es, THD_V1/2/3/avg, THD_I1/2/3/avg, Harmonics 2nd to 63rd, Crest Factor, THFF, K Factor, sequence and phase angles, DI counter, AI, AO, Dmd P/Q/S, Dmd I1/2/3		●	●
	COMMUNICATION	RS485 Port,Half Duplex, Optical Isolated	Modbus®-RTU Protocol	●	●	●
	TIME	Real Time Clock	Year, Month, Date, Hour, Minute, Second	●	●	●
OPTION MODULE	I/O OPTION	Switch Status (DI)	Digital Input (Wet)	⊙	⊙	⊙
		Power Supply for DI	24 Vdc	⊙	⊙	⊙
		Relay Output (RO)	NO, Form A	⊙	⊙	⊙
		Digital Output (DO)	Photo-MOS	⊙	⊙	⊙
		Pulse Output (PO)	By using DO	⊙	⊙	⊙
		Analog Input (AI)	0(4)~20mA, 0(1)~5V	⊙	⊙	⊙
		Analog Output (AO)	0(4)~20mA, 0(1)~5V	⊙	⊙	⊙
	COMMUNICATION	Ethernet	10M/100M, Modbus-TCP, HTTP Webpage, Email	⊙	⊙	⊙
		Profibus-DP	Profibus-DP/V0	⊙	⊙	⊙
		RS485 Module	Additional Modbus RTU	⊙	⊙	⊙

I/O Module (Option)

Module Name	Digital Input (DI)	Power Supply For DI (24V)	Digital Output (DO)	Relay Output (RO)	Analog Input (AI)	Analog Output (AO)
AXM-IO1	6	1		2		
AXM-IO2	4		2			2
AXM-IO3	4			2	2	

Communication Module (Option)

Module Name	Spec
AXM-NET	10M/100M self-adaptable, RJ45 Jack Modbus®-TCP/IP Protocol HTTP Web page browser Email sending on time interval or on event
AXM-PROFI	Profibus-DP/V0 Input Byte (typical): 32 byte Output Byte (typical): 32 Byte EN50170 vol.2 compliance Profibus slave mode, baud rate self-adaptable up to 12M
AXM-RS485	Modbus®-RTU Protocol

APPLICATIONS

- Metering of distribution feeders, transformers, generators, capacitor banks and motors
- Medium and low voltage systems
- Commercial, industrial, utility
- Power quality analysis
- Data Logging

FEATURES

Metering

- Voltage V1, V2, V3, Vlnavg, V12, V23, V31, Vllavg
- Current I1, I2, I3, In, Iavg
- Power P1, P2, P3, Psum
- Reactive Power Q1, Q2, Q3, Qsum
- Apparent Power S1, S2, S3, Ssum
- Frequency F
- Power Factor PF1, PF2, PF3, PF
- Energy Ep_imp, Ep_exp, Ep_total, Ep_net
- Reactive Energy Eq_imp, Eq_exp, Eq_total, Eq_net
- Apparent Energy Es
- Demand Dmd_P, Dmd_Q, Dmd_S, Dmd_I1, Dmd_I2, Dmd_I3
- Load Features
- Four Quadrant Powers

Monitoring

- Power Quality
- Voltage Harmonics 2nd to 63rd and THD
- Current Harmonics 2nd to 63rd and THD
- Voltage Crest Factor
- THFF (TIF)
- Current K Factor
- Voltage Unbalance Factor U_unbl
- Current Unbalance Factor I_unbl
- Max/Min Statistics with Time Stamps

Alarms

Limits can be set for up to 16 indicated parameters and can be set with a specified time interval. If any input of the indicated parameters is over or under its setting limit and persists over the specified time interval, the event will be recorded with time stamps and trigger the Alarm DO output. The 16 indicated parameters can be selected from any of the 51 parameters available.

I/O option module

The E-module® technique was adopted for its flexibility and easy expansion of the I/O function of Acuvim II. A maximum of 3 modules can be used for one meter. Digital input, digital output, pulse output, relay output, analog input and analog output are provided by I/O option module.

Communication

RS485, Industry standard Modbus®protocol
Module Option: Ethernet module, Profbus-DP module
Dual RS485 communication ports

Display

Clear and large character LCD Screen display with white back light
Wide environmental temperature endurance
Display Load percentage, 4 quadrants power and load nature

Outline

Small Size 96×96 DIN or 4" ANSI Round

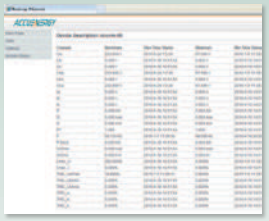
Data_logging

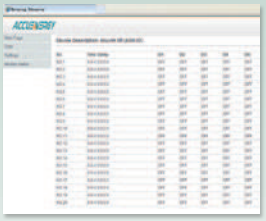
The Acuvim IIR, Acuvim IIE, model offers 4MB of onboard data logging memory to be used for historical trending. There are 3 assignable historical logs where the majority of the metering parameters can be recorded. A real time clock allows for any logged events to be accurately time stamped.

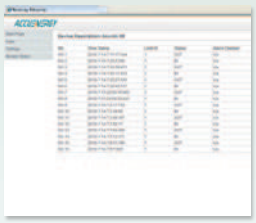
Time of use

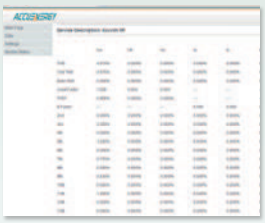
User can assign up to 4 different tariffs (sharp, peak, valley and normal) to different time periods within a day according to the billing requirements. The meter will calculate and accumulate energy to different tariffs according to the meter's internal clock timing and TOU settings.

TYPICAL WEB PAGE FROM Acuvim II SERIES


Max & Min Record

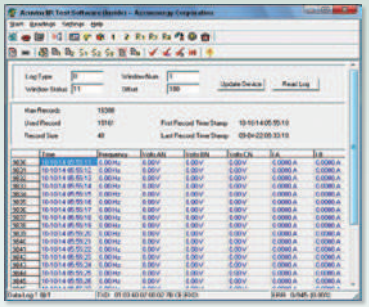

SOE Record


Alarm Record

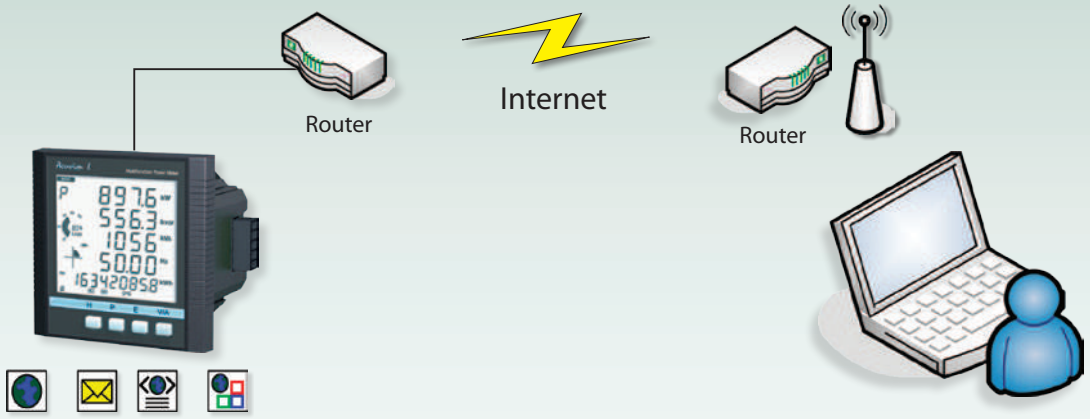

Harmonics

DATA LOGGING FROM Acuvim II SERIES

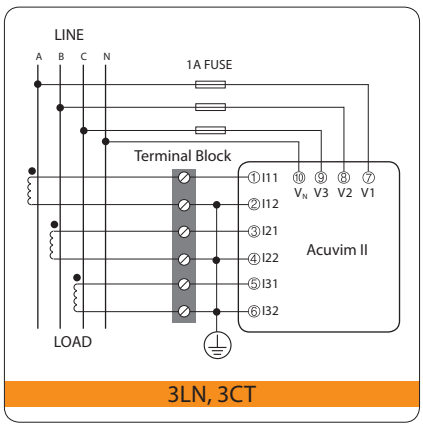
Data Logging



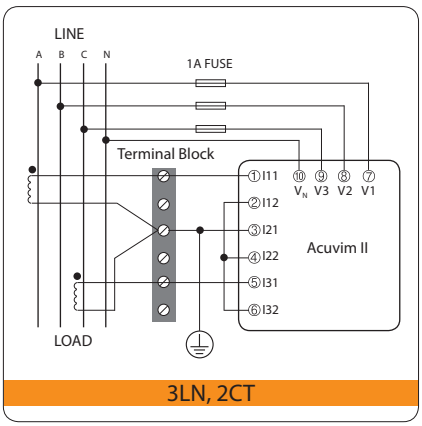
Acuvim II as Web Server



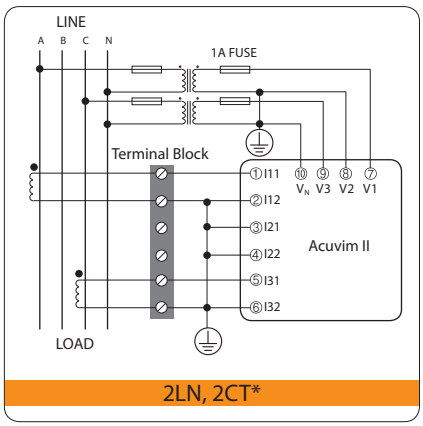
TYPICAL WIRING



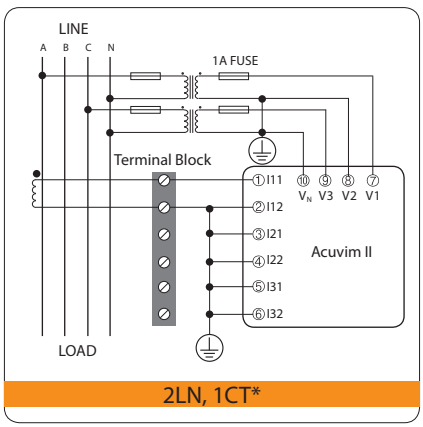
3LN, 3CT



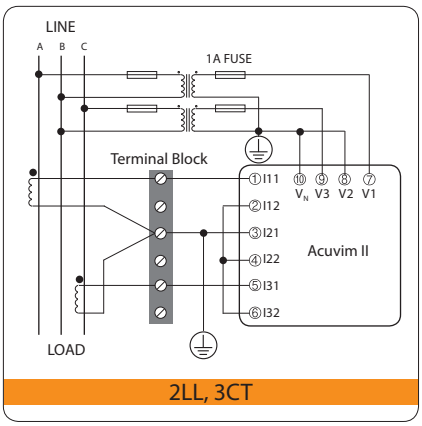
3LN, 2CT



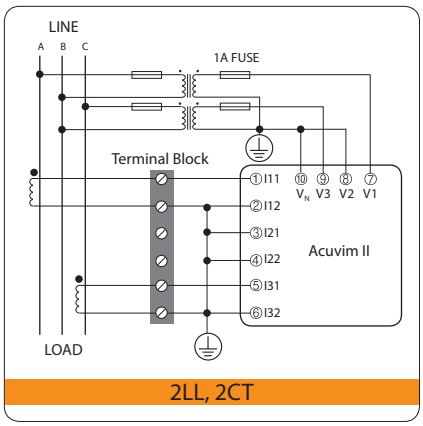
2LN, 2CT*



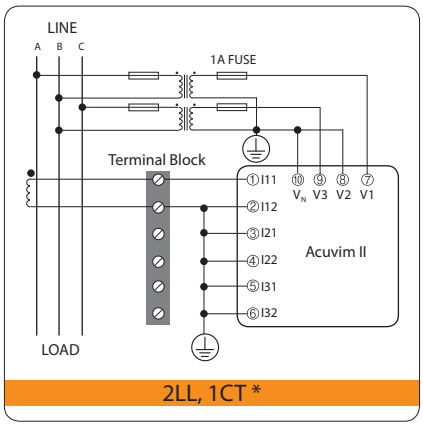
2LN, 1CT*



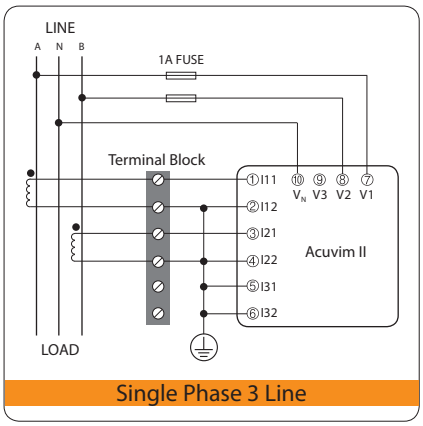
2LL, 3CT



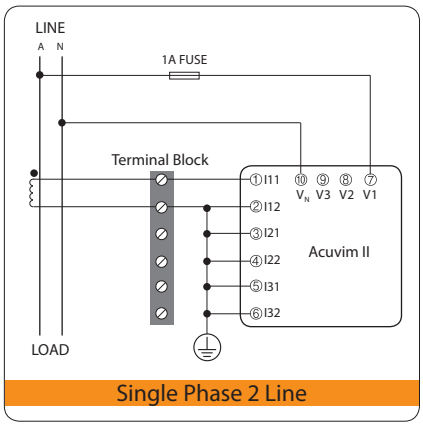
2LL, 2CT



2LL, 1CT *



Single Phase 3 Line



Single Phase 2 Line

Note: "*" wiring diagram not applicable to Acuvim IIR , Acuvim IIE

SPECIFICATIONS

METERING

Parameters		Accuracy		Resolution	Range
		Acuvim II	Acuvim IIR Acuvim IIE		
Voltage		0.2%	0.2%	0.1V	20V~1000kV
Current		0.2%	0.2%	0.1mA	5mA~50000A
Power		0.5%	0.2%	1W	-9999MW~9999MW
Reactive Power		0.5%	0.2%	1var	-9999MVar~9999Mvar
Apparent Power		0.5%	0.2%	1VA	0~9999MVA
Power Demand		0.5%	0.2%	1W	-9999MW~9999MW
Reactive Power Demand		0.5%	0.2%	1var	-9999MVar~9999Mvar
Apparent Power Demand		0.5%	0.2%	1VA	0~9999MVA
Power Factor		0.5%	0.2%	0.001	-1.000~1.000
Frequency		0.2%	0.2%	0.01Hz	45.00~65.00Hz
Energy	Primary	0.5%	0.2%	0.1kWh	0-99999999.9kWh
	Secondary	0.5%	0.2%	0.001kWh	0-999999.999kWh
Reactive Energy	Primary	0.5%	0.2%	0.1kvarh	0-99999999.9kvarh
	Secondary	0.5%	0.2%	0.001kvarh	0-999999.999kvarh
Apparent Energy	Primary	0.5%	0.2%	0.1kVAh	0-99999999.9kVAh
	Secondary	0.5%	0.2%	0.001kVAh	0-999999.999kVAh
Harmonics		2.0%	2.0%	0.01%	0.0%~100.0%
Phase Angle		2.0%	2.0%	0.1°	0.0°~359.9°
Unbalance Factor		2.0%	2.0%	0.1%	0.0%~100.0%
Running Time				0.01h	0~9999999.99h

INPUT

Current Inputs (Each Channel)

Nominal Current	5A /1A
Metering Range	0~10A ac
Withstand	20Arms continuous, 100Arms for 1 second, non-recurring
Burden	0.05VA (typical) @ 5Arms
Pickup Current	0.1% of nominal
Accuracy	0.2% full scale

Voltage Inputs (Each Channel)

Nominal Full Scale	400Vac L-N, 690Vac L-L (±20%)
Withstand	1500Vac continuous 2500Vac, 50/60Hz for 1 minute
Input Impedance	2Mohm per phase
Metering Frequency	45Hz~65Hz
Pickup Voltage	10Vac (30Vac for Acuvim IIR,Acuvim IIE)
Accuracy	0.2% full scale

Energy Accuracy (Acuvim IIR, Acuvim IIE)

Active (according to IEC 62053-22)	Class 0.2S
(according to ANSI C12.20)	Class 0.2
Reactive (according to IEC 62053-23)	Class 2

Harmonic Resolution

Metered Value	Acuvim II: 31st harmonic Acuvim IIR,Acuvim IIE: 63rd harmonic

COMMUNICATION

RS-485 (Standard)

MODBUS RTU Protocol
2-wire connection
Up to 38400 baud rate

Ethernet (Optional)

10M/100M BaseT
MODBUS® TCP/IP Protocol
Data Browsing through HTTP
Sending e-mail automatically

PROFI-BUS (Optional)

PROFIBUS-DP/V0 Protocol
Work as PROFIBUS slave, baud rate adaptive, up to 12M
Typical input bytes: 32, typical output bytes: 32
PROFIBUS standard according to EN 50170 vol.2

CONTROL POWER

Universal	AC or DC

AC/DC Control Power

Operating Range	100~415Vac, 50/60Hz; 100~300Vdc
Burden	5W
Frequency	50/60Hz
Withstand	3250Vac, 50/60Hz for 1 minute

Installation Category III (Distribution)

Low Voltage DC Control Power (Optional)

Operating Range	20~60Vdc
Burden	5W

I/O OPTION

Digital Input

Input Voltage Range	20~220Vac/dc
Input Current (Max)	2mA
Start Voltage	15V
Stop Voltage	5V
Pulse Frequency (Max)	100Hz, 50% Duty Ratio (5ms ON and 5ms OFF)
SOE Resolution	2ms

Digital Output (DO) (Photo-MOS)

Voltage Range	0~250Vac/dc
Load Current	100mA (Max)
Output Frequency	25Hz, 50% Duty Ratio (20ms ON, 20ms OFF)
Isolation Voltage	2500Vac

Relay Output (RO)

Switching Voltage (Max)	250Vac, 30Vdc
Load Current	5A(R), 2A(L)
Set Time	10ms (Max)
Contact Resistance	30mΩ (Max)
Isolation Voltage	3000Vac
Mechanical Life	$1.5x10^7$

Analog Output (AO)

Output Range	0~5V/1~5V, 0~20mA/4~20mA (Optional)
Accuracy	0.5%
Temperature Drift	50ppm/°C typical
Isolation Voltage	500Vdc
Open Circuit Voltage	15V

Analog Input (AI)

Input Range	0~5V/1~5V, 0~20mA/4~20mA (Optional)
Accuracy	0.2%
Temperature Drift	50ppm/°C typical
Isolation Voltage	500Vdc

Power Supply for DI (24Vdc)

Output Voltage	24Vdc
Output Current	42mA
Load (Max)	21 DIs

OPERATING ENVIRONMENT

Operation Temperature	- 25°C to 70°C
Storage Temperature	- 40°C to 85°C
Relative Humidity	5% to 95% non-condensing
Pollution Degree	2

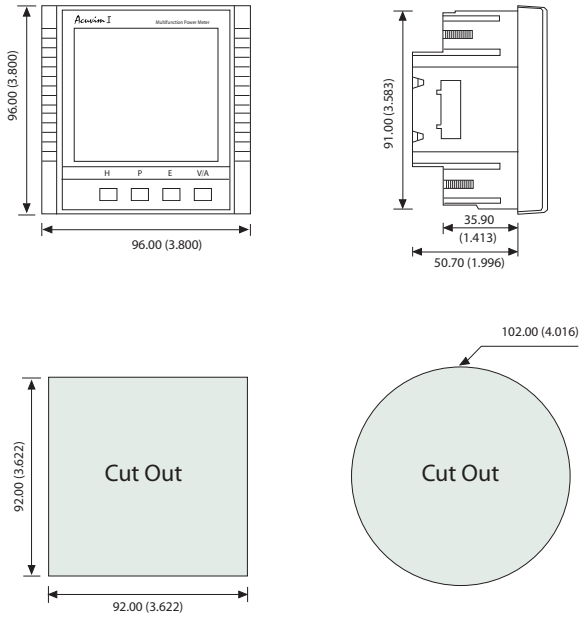
STANDARD COMPLIANCE

Measurement Standard	IEC 62053-22; ANSI C12.20
Environmental Standard	IEC 60068-2
Safety Standard	IEC 61010-1, UL 61010-1
EMC Standard	IEC 61000-4/-2-3-4-5-6-8-11, CISPR 22
Outlines Standard	DIN 43700, ANSI C39.1

DIMENSIONS

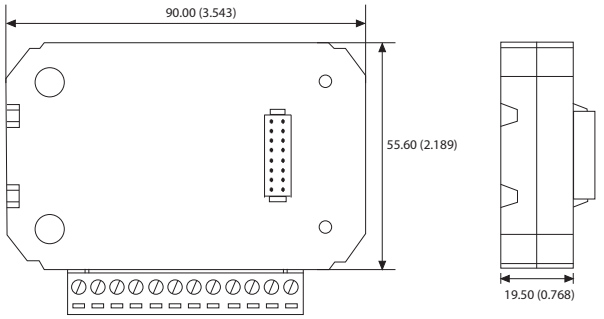
Acuvim II Dimensions

Unit: mm (inches)

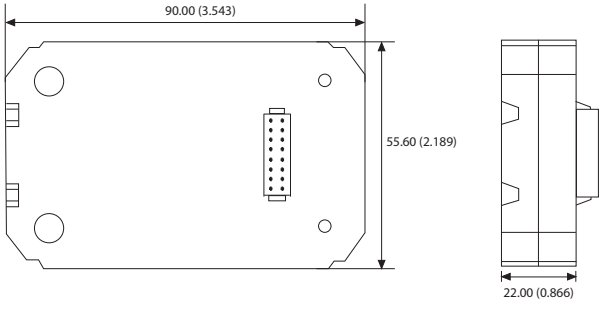


IO Module Dimensions

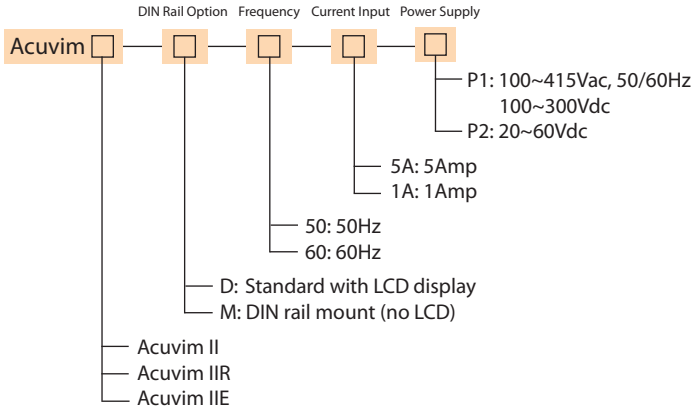
Unit: mm (inches)



Communication Module Dimensions

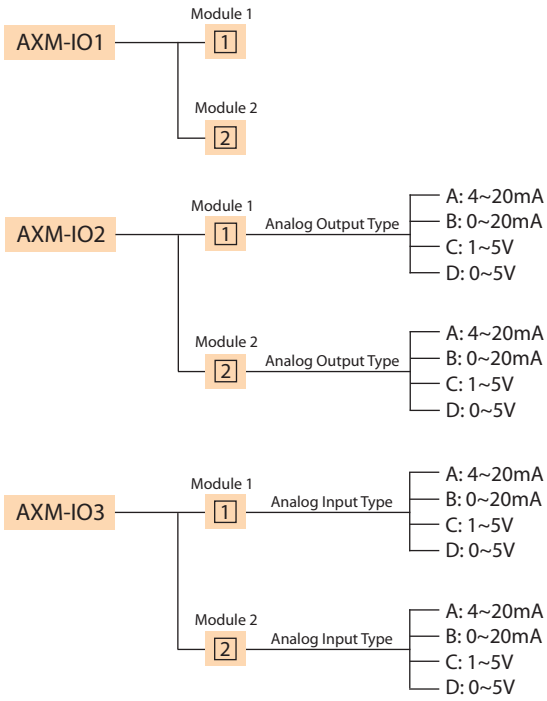


ORDERING INFORMATION



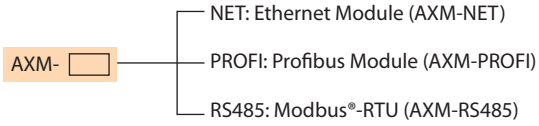
Acuvim II Base Meter Ordering Example: Acuvim IIR - 60 - 5A - P1

I/O Option module



IO Module Ordering Example: AXM-IO2-1A

Communication Option Module



Note:
1. No more than 2 of the same I/O modules may be attached to the meter (example: Two AXM-IO2). The same two IO modules must be a different component number.
2. A maximum of 3 modules may be attached to the meter. If a communication module is used (example: AXM-NET), it must be installed on the back of the meter FIRST before the other module are attached.

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Email: marketing@accuenergy.com

Revision Date: Jul., 2010
Document #1040E1104

Hawkeye® 681x-5A Series

Split-Core Current Transformers with Current Mode Output

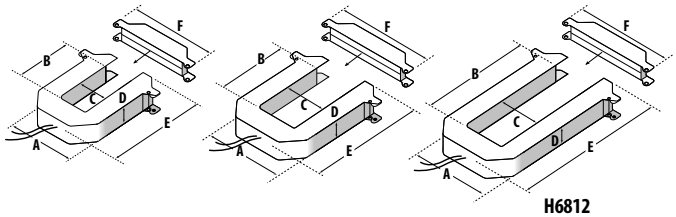
5 Year Warranty

The **Hawkeye Series** of split-core current transformers provide a 0-5AAC output for use with transducers, data loggers and chart recorders.

APPLICATIONS

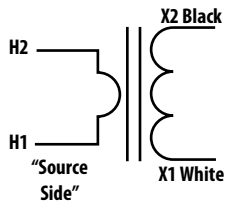
- Use with transducers
- Data logging
- Recording

DIMENSIONS



H6810 SMALL 100 Amp 200 Amp 300 Amp			H6811 MEDIUM 400 Amp 600 Amp 800 Amp			H6812 LARGE 800 Amp 1600 Amp 2000 Amp 2400 Amp		
A =	3.75"	(96 mm)	A =	4.90"	(125 mm)	A =	4.90"	(125 mm)
B =	1.51"	(38 mm)	B =	2.89"	(73 mm)	B =	5.50"	(139 mm)
C =	1.25"	(32 mm)	C =	2.45"	(62 mm)	C =	2.45"	(62 mm)
D =	1.13"	(29 mm)	D =	1.13"	(29 mm)	D =	1.13"	(29 mm)
E =	3.91"	(100 mm)	E =	5.20"	(132 mm)	E =	7.88"	(201 mm)
F =	4.75"	(121 mm)	F =	5.91"	(151 mm)	F =	5.92"	(151 mm)

WIRING



Split-Core Current Transformers

SPECIFICATIONS

Output at Rated Current	5 Amps AC
Rated Input Current	See ordering table
Frequency Range	50/60Hz
Leads	18 AWG, UL 1015 twisted pair, 6 FT. (1.8m) length
Temperature Range	-15° to 60°C*
Humidity Range	0-95% non-condensing
Insulation Class	600VAC**

** H6812-2000-5A 80 to 100% loaded, -15° to 50°C, H6810-100A-5A, accuracy & burden specified at 40°C*

***Do not apply 600V Class current transformers to circuits having a phase-to-phase voltage greater than 600V, unless adequate additional insulation is applied between the primary conductor and the current transformers. Veris assumes no responsibility for damage of equipment or personal injury caused by products operated on circuits above their published ratings.*

ORDERING INFORMATION

MODEL	RATIO	F. S. ACCURACY	BURDEN CAPACITY IN VA
H6810-200A-5A	200:5	1%	2.5VA
H6810-300A-5A	300:5	1%	2.5VA
H6811-400A-5A	400:5	1%	5VA
H6811-600A-5A	600:5	1%	5VA
H6811-800A-5A	800:5	1%	12.5VA
H6812-800A-5A	800:5	1%	5VA
H6812-1200A-5A	1200:5	1%	22.5VA
H6812-1600A-5A	1600:5	1%	22.5VA

c UL us
E207042
UL 3111-1

ACCESSORIES

Universal Mounting Bracket Kit...See page 234

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Propeller

CONFIGURATION SHEET

MODEL M0300 BOLT-ON SADDLE FLOWMETER

DESCRIPTION

The M0300 Bolt-On Saddle Flowmeter features a fabricated stainless steel saddle with McCrometer's unique drive and register design. The stainless steel saddle eliminates the fatigue-related breakage common to cast iron and aluminum saddles and provides unsurpassed corrosion protection. Fabricated stainless steel construction offers the additional advantage of being flexible enough to conform to out-of-true pipe. The Model M0300 is manufactured to comply with applicable provisions of American Water Works Association Standard No. C704-02 for propeller-type flowmeters. As with all McCrometer propeller flowmeters, standard features include a magnetically coupled drive, instantaneous flowrate indicator and straight reading, six-digit totalizer.

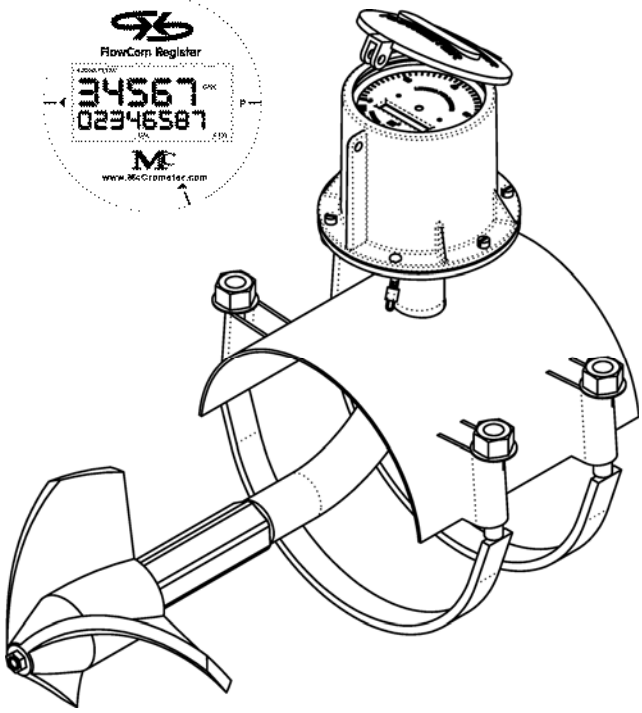
Impellers are manufactured of high-impact plastic, capable of retaining their shape and accuracy over the life of the meter. Each impeller is individually calibrated at the factory to accommodate the use of any standard McCrometer register, and since no change gears are used, the M0300 can be field-serviced without the need for factory recalibration. Factory lubricated, stainless steel bearings are used to support the impeller shaft. The shielded bearing design limits the entry of materials and fluids into the bearing chamber providing maximum bearing protection.

The instantaneous flowrate indicator is standard and available in gallons per minute, cubic feet per second, liters per second and other units. The register is driven by a flexible steel cable encased within a protective vinyl liner. The register housing protects both the register and cable drive system from moisture while allowing clear reading of the flowrate indicator and totalizer.

INSTALLATION

Standard installation is horizontal mount. If the meter is to be mounted in the vertical position, please advise the factory. A straight run of full pipe the length of ten pipe diameters upstream and two diameters downstream of the meter is recommended for meters without straightening vanes. Meters with optional straightening vanes require at least five pipe diameters upstream and two diameters downstream of the meter.

The McCrometer Propeller flowmeter comes with a standard instantaneous flowrate indicator and straight-reading totalizer. An optional FlowCom register is also available. *Typical face plates.*



APPLICATIONS

- Center pivot systems
- Sprinkler irrigation systems
- Drip irrigation systems
- Golf course and park water management
- Gravity turnouts from underground pipelines
- Commercial nurseries
- Water and wastewater management

McCROMETER

www.mccrometer.com

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SPECIFICATIONS

PERFORMANCE

ACCURACY/REPEATABILITY: ±2% of reading guaranteed throughout full range; ±1% over reduced range; Repeatability 0.25% or better
MAXIMUM TEMPERATURE: (Standard Construction) 160°F constant
PRESSURE RATING: 150 psi

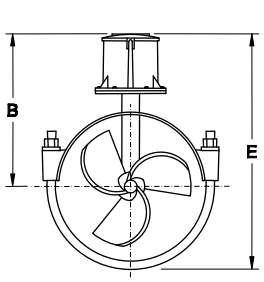
MATERIALS

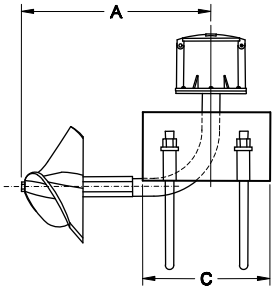
BEARING ASSEMBLY: Impeller shaft is 316 stainless steel. Ball bearings are 440C stainless steel.
MAGNETS: (Permanent type) Cast or sintered Alnico
BEARING HOUSING: Brass; Stainless Steel optional
SADDLE: 304 stainless steel construction
REGISTER: An instantaneous flowrate indicator and six-digit straight-reading totalizer are standard. The register is hermetically sealed within a die cast aluminum case. This protective housing includes a domed acrylic lens and hinged lens cover with locking hasp.

IMPELLER: Impellers are manufactured of high-impact plastic, retaining their shape and accuracy over the life of the meter. High temperature impeller is optional.

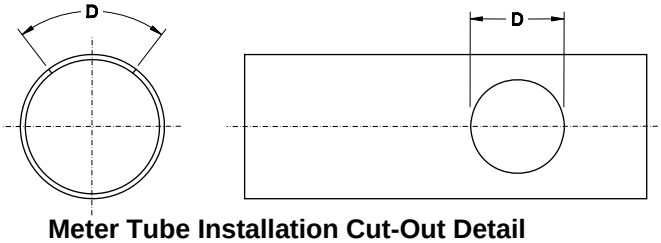
OPTIONS

- Saddle can be constructed to fit any outside diameter pipe dimensions, including metric sizes
- Can be used on a variety of pipe materials such as steel, plastic, cast iron, cement or asbestos cement
- Register extensions
- All stainless steel bearing assembly
- High temperature construction
- "Over-Run" bearing assembly for higher than normal flowrates
- Electronic propeller meter available in all sizes of this model
- A complete line of flow recording / control instrumentation
- Blank repair saddle
- Canopy boot





FLOW ⇨



Meter Tube Installation Cut-Out Detail

M0300	DIMENSIONS						
Meter and Nominal Pipe Size	**4"**	**6"**	**8"**	**10"**	**12"**	**14"**	**16"**
Maximum Flow U.S. GPM	600	1200	1500	1800	2500	3000	4000
Minimum Flow U.S. GPM	50	90	100	125	150	250	275
Approx. Head Loss in Inches at Max. Flow	23.00	17.00	6.75	3.75	2.75	2.00	1.75
Approx. Shipping Weight-lbs.	18	22	26	30	34	38	44
A (inches)	7 5/8	15	15	15	15	15	15
B (inches)	8 1/4	10 3/4	10 3/4	10 3/4	11 3/4	13 3/4	13 3/4
C (inches)	7	8	8	9 1/2	9 1/2	9 1/2	9 1/2
D (inches)	4*	5 1/8*	6*	7*	7 1/4	7 1/4	7 1/4
E (inches)	10 3/4	14	15	17	19	20 5/8	21 5/8

For larger sizes see Model M1400. *McCrometer reserves the right to change design or specification without notice.*
**Standard pipe only. For other than standard pipe, consult factory for cutout dimensions.*
Please specify the inside diameter of the pipe when ordering.

FOR MORE INFORMATION CONTACT:

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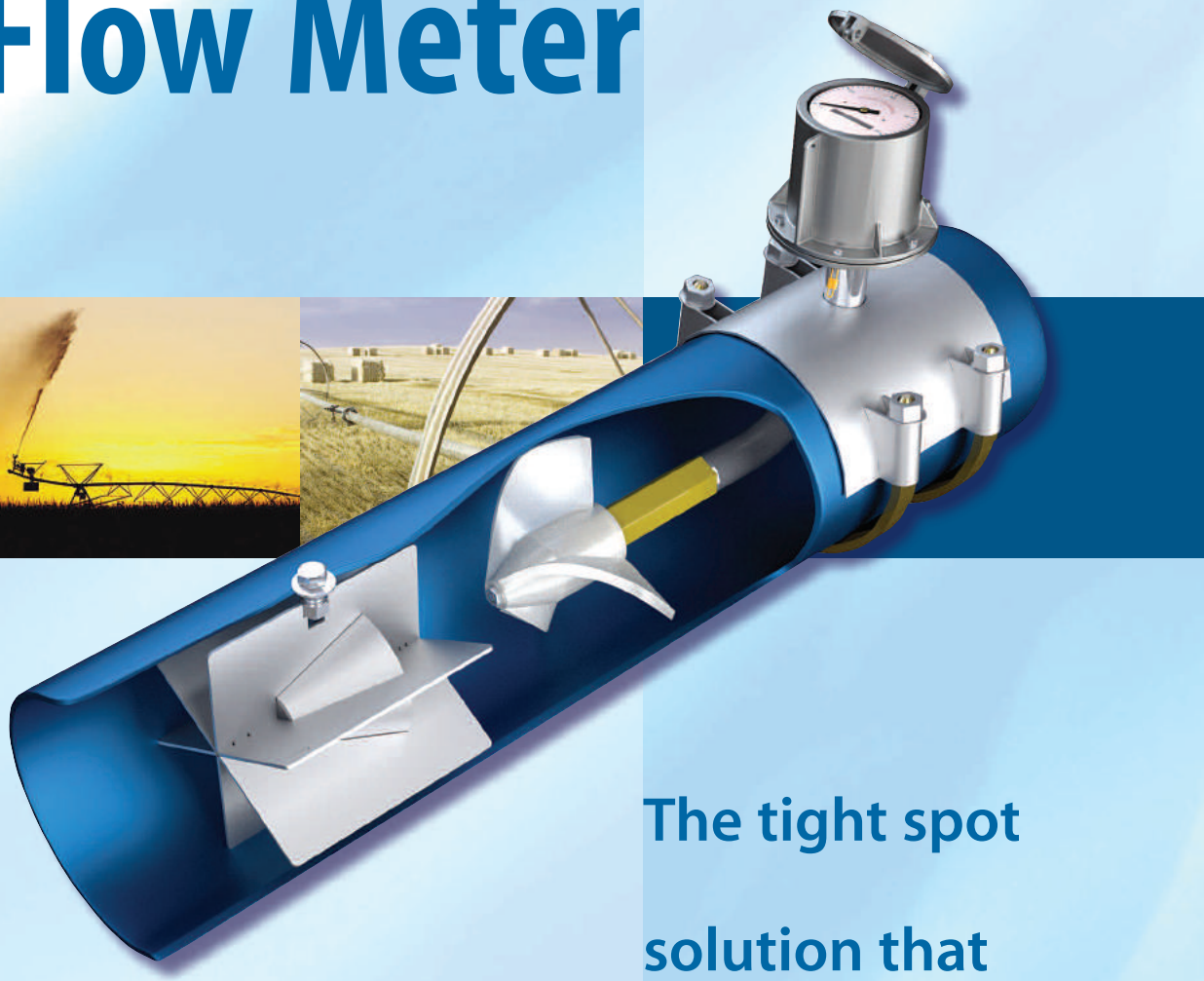
Mc SpaceSaver™ Flow Meter



The tight spot solution that saves money

McCROMETER
The Flow Specialists for 50 Years

McSpaceSaver: The tig

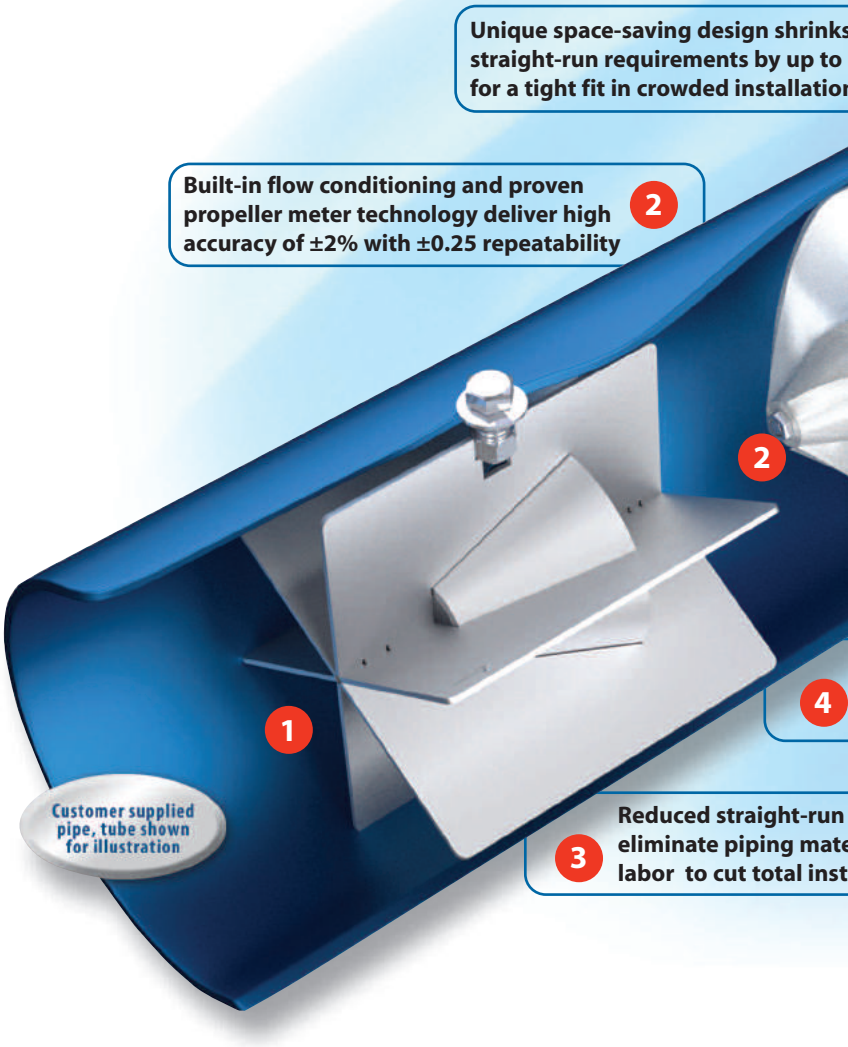
Conserve water and **save** money with the **high accuracy** flow meter **that fits** almost **anywhere**

Developed with a breakthrough design that combines advanced flow conditioning and propeller meter technologies, the Mc SpaceSaver™ Flow Meter from McCrometer delivers superior accuracy, lower installation costs and long-life with low maintenance. It's the ideal money-saving flow measurement solution to help farmers, water district engineers and irrigation dealers cope with the latest water metering programs.

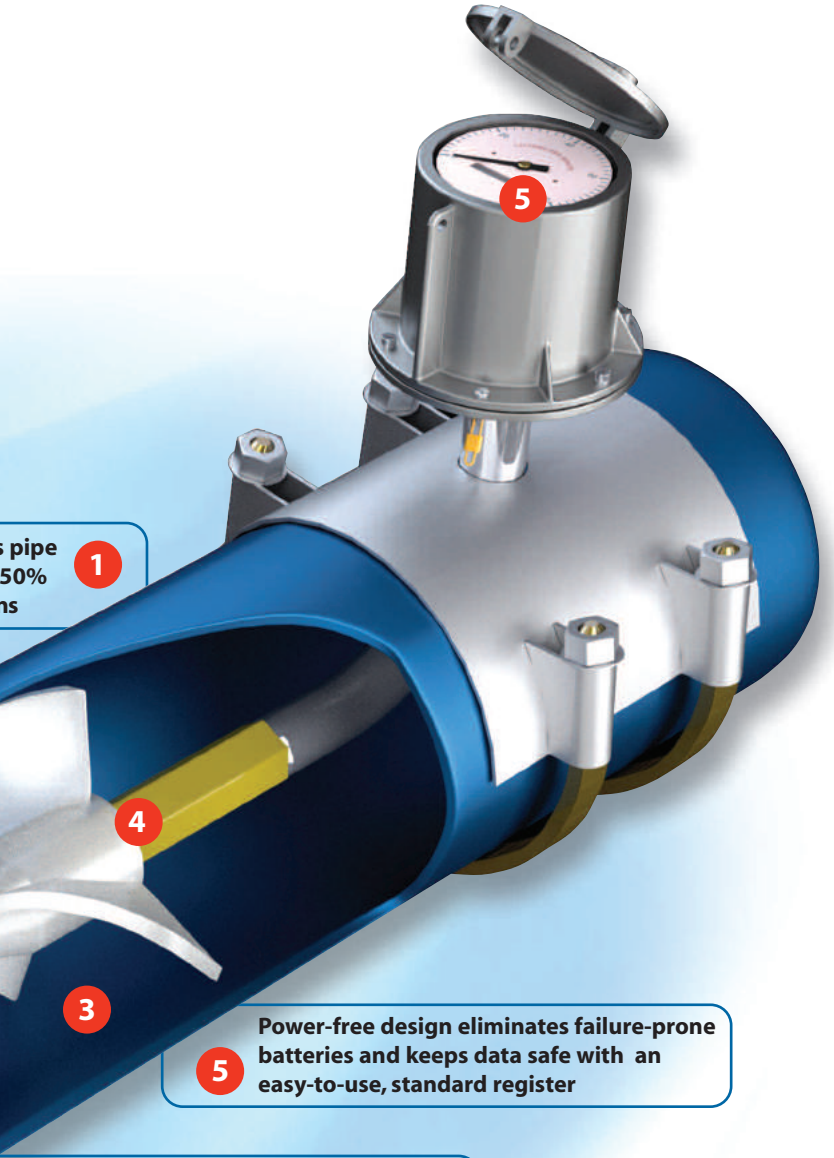
For more than 50-years, McCrometer has been the leader in developing innovative flow measurement solutions designed specifically for rugged agricultural and turf irrigation operations. The first McCrometer flow meters were designed for farmers by farmers who knew first-hand the challenge of bringing water reliably and efficiently to crops without wasting a drop or a nickel.

How flow conditioning works

The Mc SpaceSaver Flow Meter operates over a wide 15:1 flow range and supports the most popular 6 and 8-inch irrigation line sizes. It is designed with a built-in flow straightener assembly that greatly enhances measurement performance. As the upstream flow in an irrigation line approaches the Mc SpaceSaver, its built-in straightener mixes and shapes the liquid flow into a smooth stream before it reaches the impeller to optimize measurement performance.



ght spot meter



s pipe
50%
ns
1

5 Power-free design eliminates failure-prone batteries and keeps data safe with an easy-to-use, standard register

Advanced propeller meter prevents solids build-up for trouble-free performance in rugged agricultural and turf operations

requirements
erial and extra
allation costs

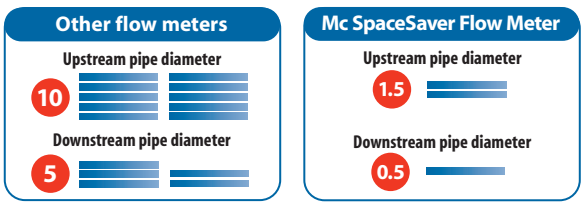
The result is greater flow measurement accuracy, in real world installations of up to ±2 percent, with ±0.25 percent repeatability. The Mc SpaceSaver's built-in flow straightener allows it to be installed in close proximity to chemigation, butterfly and gate valves, or out-of-plane elbows, and reducers with excellent measurement stability -- compared to mag and other flow meters, which specify accuracy based on ideal laboratory flow conditions.

The Mc SpaceSaver is designed with heavy-duty propeller meter technology for rugged agricultural service. Featuring a self-cleaning propeller design, the Mc SpaceSaver prevents the build-up of solids. Its unique magnetic coupling system keeps the register drive isolated from the flow while permitting unrestricted movement of the impeller. Free rotation of the impeller also is assured by factory-lubricated stainless steel bearings.

The straight story on straight runs

The advanced Mc SpaceSaver from McCrometer is a total system solution, featuring a built-in flow straightener to condition water flow, which virtually eliminates the upstream/downstream straight pipe runs typically required in existing or new flow meter applications.

Straight pipe requirements



Requiring only a minimum of 1.5 straight pipe diameters upstream and 0.5 downstream, the Mc SpaceSaver reduces typical installation piping and labor costs by more than 50 percent, which makes it the right fit for both retrofit and in brand new installations.

Flow rate indicator and totalized flow output

The Mc SpaceSaver Flow Meter comes with a standard instantaneous flow rate indicator and a straight-reading totalizer. Unlike mag and other types of flow meters, the Mc SpaceSaver requires no electric power to operate. With no Lithium batteries to fail in extreme heat or cold or humidity, your valuable flow data is continuously available and safe via the Mc SpaceSaver's standard register.

The versatile water measurement solution

- Agriculture irrigation
- Turf irrigation
- Drip and sprinkler systems
- Greenhouse growers
- Pumping stations
- Canal laterals
- Golf course
- Park management
- Center pivot systems

Mc SpaceSaver Specifications

Mc SpaceSaver consists of: MO300F Flow Meter and FS100 Flow Straightener

Minimum Upstream Straight Run: 1.5 pipe diameter minimum (measured from propeller)

Acceptable Installation Effects: Chemigation Valves, in plane elbows, out of plane elbows, fully open butterfly and gate valves

Sizes: 6" and 8" nominal and OD pipe

Customer Pipe Wall: **Metal:** ≥0.08, <0.5 **Plastic:** ≥0.25, <0.5

For M0300F Installation: Inserted into pipeline through rectangular hole and locked in place by a single 1/2 or 5/8 inch bolt. The M0300F Flow Meter is designed to cover the rectangular hole used to install the flow straightener.

For Existng M0300 Installation: Inserted into pipeline through open end of pipeline and locked in place by a single 1/2 or 5/8 inch bolt.

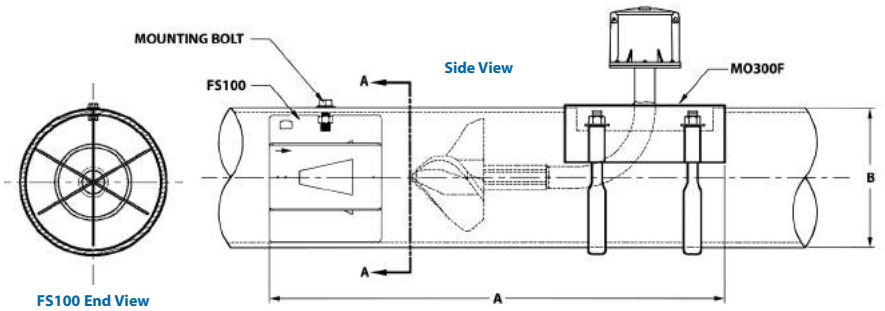
Installation Bolt: Stainless steel with dual seal.

Body M0300F: Fabrication 304 stainless steel saddle with stainless steel drop pipe is supplied with: brass bearing housing, stainless steel bearings, polypropylene impeller, magnetic drive, instantaneous flow indicator, straight-reading six-digit totalizer, and flat neoprene gasket.

Body FS100: 304 stainless steel

Exterior: Glass bead blasted

Pressure Rating: 150 psi maximum



Customer supplied pipe, tube shown for illustration.

	Model M00300F Flow Meter Models							
M0300F Model	M0306-F	M0306-F	M0306-F	M0306-F	M0308-F	M0308-F	M0308-F	M0308-F
	FS100 Flow Straightener Models							
FS100 Model	FS106-1	FS106-2	FS106-3	FS106-4	FS108-1	FS108-2	FS108-3	FS108-4
Pipe OD (B)	6.625	6.625	6.0	6.0	8.625	8.625	8.0	8.0
Wall Thickness Range	0.08-0.199	0.2-0.32	0.8-0.156	0.157-0.260	0.08-0.209	0.21-0.34	0.08-0.161	0.162-0.260
'A' with M030xF Flow Meter	22	22	22	22	28 5/8	28 5/8	28 5/8	28 5/8
'A' with M030x Flow Meter	26 1/4	26 1/4	26 1/4	26 1/4	31 1/8	31 1/8	31 1/8	31 1/8
FS100 Shipping Wt. (lbs.)	3.3	3.2	3.0	2.9	5.9	5.7	5.5	5.3
M0300F Shipping Wt. (lbs.)	22	22	22	22	26	26	26	26

Notes: 1. Legal protection pending; 2. M0300F Flow Meter, shown in diagram above, provided separately; 3. Upon request: special pipe diameter and special wall thickness; 4. Select the appropriate M0300F and FS100 for a complete Mc SpaceSaver system; 5. Refer to 24510-68 McSpaceSaver configuration sheet for additional sizes.

McCROMETER
The Flow Specialists for 50 Years

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GE
Measurement & Control Solutions

TransPort®
PT878

Panametrics Portable Liquid Ultrasonic Flowmeter

Applications

The TransPort PT878 portable liquid flowmeter is a complete portable ultrasonic flow metering system for measurement of:

- Potable water
- Wastewater
- Cooling and heating water
- Ultrapure water and liquids
- Water/glycol solutions
- Crude oil
- Refined hydrocarbons
- Diesel and fuel oils
- Lubricating oils
- Chemicals
- Beverages
- Other liquids

Features

- Small, lightweight and easy-to-use
- Non-intrusive flow measurement
- Velocity, volumetric and energy flow rates
- Totalized flow and trend data
- Large, backlit LCD display
- Alphanumeric and graphic formats
- Multiple-language user interface
- Rechargeable battery pack
- Logs over 100,000 flow data points
- Submersible package
- 32 site locations
- Optional thickness gauge
- Optional energy measurement
- Suitable for most pipe sizes and materials, including lined pipe

Portable Flow Metering at Its Best

The TransPort PT878 flowmeter is a highly versatile, self-contained, portable transit-time system with options and accessories to meet all your liquid flowmeasurement needs. Its compact size; lightweight, rechargeable internal battery pack; and universal power supply charger make it the ideal go-anywhere flowmeter.

Accurate with Two-Phase and Perfectly Clean Liquids

The TransPort PT878's patented Correlation Transit-Time™ digital signal processing (DSP) technique greatly increases its signal-to-noise ratio for accurate, drift-free flow measurement in liquids that contain a second phase of entrained solids or gas bubbles. The TransPort flowmeter operates in these and other difficult applications where conventional transit-time flowmeters fail.

The TransPort PT878 flowmeter also accurately measures flow rate in perfectly clean liquids containing no "scatterers," where Doppler-type flowmeters cannot work. The TransPort flowmeter is suited for all standard transit-time applications, plus many that would prevent other transit-time flowmeters from working.

Quick and Easy to Use

It's possible to make your first flow measurement within minutes of opening the box—the TransPort flowmeter is that easy to use. Simply input the site parameters, clamp the transducers onto the pipe, adjust the spacing, and you're under way. No ancillary equipment is needed, and there's no need to break into the pipeline. An experienced user can make scores of different measurements in a single day. The TransPort PT878 flowmeter is ideal for all kinds of flow survey work.

Flow Transducers and Clamping Fixtures

Using clamp-on transducers, the TransPort PT878 flowmeter measures flow rate through metal, plastic or even concrete-lined pipes, without penetrating the pipewall. From ultra-pure water to corrosive and toxic liquids, the TransPort PT878 flowmeter ensures noncontaminating, leak-free measurement with drift-free accuracy. The TransPort PT878 flowmeter has no moving parts to wear or orifices to clog. It can't be fouled, and it requires no routine maintenance.

A wide variety of transducers are available with different operating frequencies, materials of construction, operating temperatures and sizes to meet the requirements of rugged industrial environments.

To hold clamp-on transducers in contact with the pipe, a variety of clamping fixtures are available to accommodate different pipe and transducer sizes. These fixtures use a variety of attachment methods including chain, metal strap, Velcro® strap and magnetic clamps.

Alphanumeric and Graphic Liquid Crystal Display Completes the Picture

A large, multifunction LCD presents measured data in both alphanumeric and graphic forms. In addition, it helps make programming easy by presenting a software menu that walks you through data entry and function selection.

Standard alphanumeric functions include flow velocity, volumetric or energy flow rates, and totalized flow in either English (U.S.) or metric units.

In graphic mode, the LCD shows both real time and logged data. The result is a chart recording right on the display, which is very useful for reviewing data and observing trends while on the site.

Submersible, Rugged Electronics Housing

Your investment in this flowmeter is protected from the day-to-day rigors of industrial usage. The TransPort PT878 is equipped with a rubber boot that provides protection against vibration and shock.

The completely sealed housing and ports meet IP67 requirements, so the unit will withstand submersion in up to 3 ft (1 m) of water for limited periods of time. It will continue to function safely even if it is dropped in water. The complete TransPort PT878 flowmeter system fits in a compact carrying case.

Optional Energy Measurement

The TransPort PT878 flowmeter combines proven ultrasonic flow measurement with precise RTD temperature measurement to determine the energy flow rate in liquid heating and cooling systems. With this option, the TransPort flowmeter comes equipped with a built-in power supply for loop-powered RTD temperature sensors, as well as all necessary circuitry and software to make energy flow rate measurements. The energy kit option includes two matched Pt1000 surface mount RTDs with 30 feet of cable to plug into the PT878,

Optional Pipe Wall Thickness Gauge Transducer

Pipe wall thickness is a critical parameter used by the TransPort flowmeter for clamp-on flow measurements. The thickness-gauge option allows accurate wall thickness measurement from outside the pipe.

Infrared Port

The TransPort PT878 contains an infrared port for communication with your PC. If your laptop or desktop PC does not have infrared capability, an adapter is available that can be plugged into your PC’s serial port.

Optional Infrared Thermal Printer and Accessories

When you need a permanent record of your work, live measurements, logged data and site parameters can be sent to a variety of printers by beaming data directly from the TransPort PT878's infrared port. A compact, lightweight, hand-held, infrared thermal printer is available. This printer is powered by a lithium ion battery.

Built to Be Economical and Stay Economical

To be of real value, a portable flowmeter must be as economical to own and operate as it is capable in the field. The TransPort PT878 flowmeter is built to stay in service for many years. Completely solid state, the device rarely wears out or needs servicing, resulting in little downtime and low maintenance costs.

The TransPort PT878 Flowmeter Uses the Transit-Time Flow Measurement Technique

In this method, two transducers serve as both ultrasonic-signal generators and receivers.
When mounted on a pipe, they are in acoustic communication with each other, meaning that the second transducer can receive ultrasonic signals transmitted by the first transducer and vice versa.
In operation, each transducer functions as a transmitter, generating a certain number of acoustic pulses, and then as a receiver for an identical number of pulses.
The time interval between transmission and reception of the ultrasonic signals is measured in both directions. When the liquid in the pipe is not flowing, the transit-time downstream equals the transit-time upstream. When the liquid is flowing, the transit-time downstream is less than the transit-time upstream.
The difference between the downstream and upstream transit times is proportional to the velocity of the flowing liquid, and its sign indicates the direction of flow.

Ultrasonic Signal Path
Flowmeter Transducers
Fluid
Flow

Transit-time flow measurement technique

The core of the kit includes the PT878 electronics, along with a power charger with North American, European, or United Kingdom power cable.
A variety of transducer kits are available to handle a wide range of applications. Selection is based on pipe size and temperature range. More transducers can be added to the kit by ordering separately if the desired combination is not available as part of a standard kit.
The PT878 comes standard with a soft sided carrying case. Made from lightweight, durable nylon, this case is excellent for everyday use.
The PT878 offers an optional hard case when durability is more important. This is ideal for traveling and shipping purposes, or in environments where nylon

bags are not suitable.
Knowing the wall thickness of your pipe is critical to ensuring your meter provides the best possible accuracy. Wall thickness on standard pipe can vary up to 13%. The PT878 comes standard with the ability to measure pipe wall thickness. This requires the use of a thickness gage that plugs directly into the transducer ports. There is no need for a separate device.
Select option code — TG.
Measuring energy usage in buildings is increasing in importance. The PT878 can measure energy by using the optional 4-wire, 1000 Ohm RTDs with integrated transmitters to spot check applications and test existing meters monitoring the line.
Select option code — E
A variety of clamping fixtures are available to simplify attaching the transducers to the pipe. Transducers are integrated into the small pipe transducers up ot 2” lines. For larger pipes, the transducers ship with clamps that range up to 24” pipes. For pipes up to 48”, a larger pipe clamp is available with chains. If all the pipes are made from carbon steel, magnetic clamping fixtures may be the best option for fast setup.
Select option code — C48 for large clamping fixtures.
Order MC style clamping fixtures for magnetic fixtures.
The PT878 uses an IR port to transfer data between the unit and a PC. If your PC or laptop does not have an IR port, you need an IR adapter. We offer one that will plug into a USB port.
Select option code — IR
.
The PT878 can output data to a data acquisition system to act as a temporary replacement for a failed permanent meter or to provide a temporary monitoring point. An input/output cable will be necessary to provide 4-20 mA or pulse outputs from the PT878.
Select option code — IO
.

PT878 Specifications

Operation and Performance

Fluid Types

Acoustically conductive fluids, including most clean liquids, and many liquids with entrained solids or gas bubbles. Maximum void fraction depends on transducer, interrogation carrier frequency, path length and pipe configuration.

Pipe Sizes

0.5 in to 300 in (12.7 mm to 7.6 m) and larger

Pipe Wall Thickness

Up to 3 in (76.2 mm)

Pipe Materials

All metals and most plastics. Consult GE for concrete, composite materials, and highly corroded or lined pipes.

Clamp-On Flow Accuracy (Velocity)

• Pipe ID>6 in (150 mm): ±1% to 2% of reading typical
• Pipe ID<6 in (150 mm): ±2% to 5% of reading typical
Accuracy depends on pipe size and whether measurement is one-path or two-path. Accuracy to ±0.5% of reading may be achievable with process calibration.

Repeatability

±0.1% to 0.3% of reading

Range (Bidirectional)

–40 to 40 ft/s (–12.2 to 12.2 m/s)

Rangeability (Overall)

400:1

Specifications assume a fully developed flow profile (typically 10 diameters upstream and 5 diameters downstream of straight pipe run) and flow velocity greater than 1 ft/s (0.3 m/s).

Measurement Parameters

Volumetric flow, totalized flow and flow velocity

Electronics

Flow Measurement

Patented Correlation Transit-Time mode

Enclosure

Submersible IP67

Dimensions

Weight 3 lb (1.36 kg),
Size (h x w x d) 9.4 in x 5.5 in x 1.5 in
(238 mm x 138 mm x 38 mm)

Display

240 x 200 pixel backlit LCD graphic display

Keypad

25-key rubberized tactile membrane keypad

Internal Battery

Rechargeable battery: 9 to 11 hr of continuous operation

Battery Charger Input

100 to 250 VAC, 50/60 Hz, 0.38 A

Memory

FLASH memory, field-upgradable

Operating Temperature

–4°F to 131°F (–20°C to 55°C)

Storage Temperature

–40°F to 158°F (–40°C to 70°C)

To ensure maximum battery life, storage temperature exceeding 35°C (95°F) is not recommended for more than one month.

Standard Inputs/Outputs

• One 0/4 to 20 mA current output, 550 W maximum load
• One user-selectable pulse (solid state, 5 V maximum) or frequency (5 V square wave, 100 to 10,000 Hz)
• Two 4 to 20 mA analog inputs with switchable power supply for loop-powered temperature transmitters

Digital Interface

Infrared communication port for printer or PC interface

Site-Parameter Programming

• Menu-driven operator interface using keypad and “soft” function keys
• Online help functions including pipe tables
• Storage for saving site parameters

Data Logging
• Memory capacity to log over 100,000 flow data points
• Keypad programmable for log units, update times, and start and stop time

Display Functions
• Graphic display shows flow in numerical or graphic format
• Displays logged data
• Extensive diagnostic parameters
• Supports multiple languages: Dutch, English, French, German, Italian, Japanese, Portuguese, Russian, Spanish, Swedish and others

European Compliance
Battery-powered system complies with EMC Directive 89/336/EEC and transducers comply with PED 97/23/EC for DN<25

Clamp-On Ultrasonic Flow Transducers

Temperature Ranges
• Standard: –40°F to 300°F (–40°C to 150°C)
• Optional (overall range): –310°F to 572°F (–190°C to 300°C)

Mountings
Stainless steel chain or strap, welded or magnetic clamping fixtures

Area Classifications
• Standard: General purpose
• Optional: Weatherproof Type 4/IP65
• Optional: Submersible IP67/68
PT878 electronics are designed for general purpose areas.

Transducer Cables
• Standard: One pair of LEMO® coaxial transducer connectors with 25-ft (8-m) cables
• Optional: 1,000-ft (305-m) extension cables available for most transducers

Thickness-Gauge Option

Transducer
Dual-element transducer

Pipe-Thickness Range
0.05 in to 3 in (1.3 mm to 76.2 mm)

Pipe Materials
Most standard metal and plastic pipe materials

Accuracy
±1% typical or ±0.002 in (±0.05 mm)

Thermal Exposure
Continuous operation to 100°F (37°C); intermittent operation to 500°F (260°C) for 10 sec followed by 2 min air cooling

Energy Measurement

Energy Measurement
Calculates energy flow rate and totalized energy. Requires optional energy kit.

Temperature Transducers
Loop-powered, 4-wire Pt1000 surface-mount RTDs

Accuracy
±0.12°C of temperature)
Range
32°F to 300°F (0°C to 150°C) standard
The accuracy of the energy measurement is a combination of the accuracy of the associated flow and temperature measurements. 1% to 2% of reading is typical for calibrated systems. Not all extremes of parameters can be achieved simultaneously.

Additional Options
PC-Interface Software
The TransPort PT878 communicates with a PC through the infrared interface and Windows® operating systems. Consult the manual for details on sites, logs and other operations with a PC.
Printer
• Infrared, portable, thermal printer with rechargeable battery and 120 to 240 VAC power supply/recharger
• Weight 13 oz (370 g), size 6.3 in x 6.5 in x 2.3 in (160 mm x 164.2 mm x 59 mm), print width 4 in (104 mm)
RS232-to-Infrared
Infrared adapter plugs into any available serial port to give desktop PCs infrared capability.

920-039D

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Ordering Information

Language 1 English language only
2 German and English languages
3 French and English languages
4 Italian and English languages
5 Spanish (South American) and English languages
6 Spanish (Castilian) and English languages
7 Portuguese and English languages
8 Russian and English languages
9 Swedish and English languages
10 Dutch and English languages
11 Japanese and English languages
Power Cord 1 North American
2 European
3 United Kingdom
Carry Case SC Standard softshell case; Ideal for everyday users
H Optional hard shell case; Ideal for shipping and travel purposes.
Transducer Kit 0 No Transducers
A -40 to 150 °C applications, 2” to 24” pipes (C-RS-402)
B High temperature -40 to 230 °C applications, 1/2” to 2” pipes (CF-LP-2EM-40HM-6)
C -40 to 150 °C applications, 6” and larger pipes (C-RS-401). Requires extensions for up to 48” lines or magnetic clamping fixtures for pipes larger than 24”.
D Combination kit of options A and B
E Combination kit of options A, B and C
F High temperature -20 to 210°C applications, 2” to 24” pipes (C-PT-10-HT)
G Combination kit of options B and F
Accessories TG Thickness Gage
E Energy kit with matched pair Pt 1000, surface mount RTDs with transmitters and I/O cable
C48 Clamping fixture for up to 48 inch lines
IO I/O cable
IR USB to IR Converter
FV 6 Point Flow Verification Test on traceable loop

PT- SYS — — — — —

GreenStar™

Ag Management Solutions from John Deere

JOHN DEERE

Innovative technologies, exceptional support

A beacon for profit, at every level

Just as there are different agronomic practices, operators require different accuracy levels. Using our own StarFire™ network we can provide you with a reliable, accurate, and repeatable signal customized to your needs, delivering the accuracy and control you demand.

Get reception that's made for the shade with the ***new*** StarFire™ 3000 Receiver

If you have heavily-treed fence lines or hilly ground, then you need the new StarFire™ 3000 Receiver. It delivers outstanding reception in shaded conditions, holding a signal longer and reacquiring it faster than any previous model. That means maximum up-time and accuracy for you.

But that's not all. The StarFire 3000 also provides improved performance in sloping terrain, as well as increased satellite availability through GLONASS*, the Russian satellite constellation. Finally, the StarFire 3000 offers the ease of over-the-air receiver activation. Add it all up, and you have a receiver that's made not just for the shade, but for any conditions you can throw at it.

**GLONASS is in base and is only compatible with RTK accuracy at this time. Additional signals will become available in 2011*

StarFire™ 3000

With this receiver you can get started into precision guidance at the accuracy level you need at the time. From Parallel Tracking to precision-guidance AutoTrac Assisted Steering, to the one-inch, repeatable accuracy of StarFire RTK, the StarFire 3000 Receiver growd with you.

Compatible Displays[Δ]:
GreenStar 2 1800 and GreenStar 3 2630

StarFire™ 300

Easy to install and even easier to afford, the StarFire 300 and the GreenStar™ Lightbar are ideal for Parallel Tracking.

Compatible Displays[Δ]:
GreenStar 2 1800 and GreenStar 3 2630

Accuracy Level	StarFire 300	StarFire 3000
WAAS*: +/- 13-in.	●	●
SF1†: +/- 10-in.		●
SF2†: +/- 4-in.		●
RTK¤: +/- 1-in.		●

†SF1 and SF2 accuracy levels are described on a pass to pass basis measured at the receiver, within 15 minutes, 95% of the time.

¤RTK accuracy is expressed as an absolute value (without +/-) because RTK performance is not subject to GPS drift over time. RTK accuracy levels are described on a static basis measured at the vehicle receiver, 68% of the time within 12 miles line of sight with the base station, assuming unobstructed view of the sky, favorable PDOP, and correct base station setup.

**WAAS is a government-sponsored differential correction signal with a static accuracy of approximately 75 cm (30 in.). This signal has no guarantee as to how long it will be available or when planned outages for maintenance are scheduled. WAAS is a low-level accuracy that is a free service for John Deere customers. WAAS pass to pass accuracy is +\- 13 inches.*

Customized signal accuracy

John Deere is the only company in the precision ag market to offer its own differential corrections through the StarFire™ Network, so you know who will be there to support you. It's true that everyone uses the same raw GPS, but differential correction is a different story.

StarFire™ SF1.

The John Deere-exclusive free SF1 differential correction signal delivers +/- 10-inch pass-to-pass accuracy, ideal for tillage, seeding, and broad-acre spraying.

StarFire™ SF2.

For those users who need higher accuracy, the StarFire 3000 can be upgraded to SF2 Ready. SF2 delivers +/- 4-inch pass-to-pass accuracy, which is ideal for row-crop planting. A SF2 subscription is also required.

StarFire™ RTK.

Use cropping practices that require the ultimate in accuracy? Then go with RTK. It provides +/- 1-inch accuracy and repeatability pass to pass. Take advantage of a John Deere dealer-owned RTK network, or set up your own.

Dealer-owned RTK Networks

Hundreds of millions of acres are covered and supported by John Deere dealer-owned RTK networks. And because the towers are supported by your local dealer, you can operate with the confidence that someone you know and trust will be there to answer your call when you need them.

StarFire™ RTK Radios

The new StarFire™ 450 RTK Radio (FCC license required) offers uncompromising accuracy for cropping practices that demand extreme precision. It increases your signal coverage and maintains RTK's one-inch accuracy, even in challenging terrain or dense foliage conditions. The StarFire 450 RTK Radio can be used on your tractor, as well as on the same base station as a StarFire 900 RTK Radio. Comfortable with your current signal level? Then opt for the StarFire 900 RTK Radio (no license required).

The right support.

There's certainly an impressive list of reasons to invest in a GreenStar Precision Ag System... but one of the best reasons is the long line of people who stand behind every product. We encourage you to visit your GreenStar Certified Dealer today. Your dedicated and specially trained AMS consultant is ready to help you get the most out of your GreenStar experience.

The support you need, when you need it:

– GreenStar Certified Dealer
– 24/7 phone support, available 362 days a year - 1-888-GRN-STAR
– NEW Activation line, effective November 2010: 888-953-3373
– www.StellarSupport.com

Display	GS3 2630*	GS2 1800*	GS Lightbar
FEATURES			
Color screen	●	●	
Touch Screen	●		
Integrated Display Control		●	
ISOBUS Compatible	●	●	
USB Data Port	●	●	
Screen Size	10.4 in.	7 in.	
On-Screen Mapping	●	●	
Boundaries	●	●	
Flags	●		
Access Manager	●		
Video Capbility	●		
Stand-by Mode	●		
GUIDANCE			
AutoTrac™ SF1	●	●	
AutoTrac™ SF2	●	●	
StarFire™ RTK	●	●	
Manual Guidance (Parallel Tracking): Straight	●	●	●
Manual Guidance (Parallel Tracking): Curved	●	●	●
Manual Guidance (Parallel Tracking): Circle	●	●	●
StarFire™ Receiver Compatibility	●*	●*	
GreenStar™ Lightbar Compatible	●	●	
DOCUMENTATION *(GREENSTAR BASICS)*			
Harvest Doc™	●		
Field Doc™	●		
Map Based Prescriptions	●		
PRO MODULES			
Pivot Pro	●	●	
iGuide™	●		
iTEC™ Pro	●		
Surface Water Pro™	●		
Surface Water Pro™ Plus	●		
Swath Control Pro™	●	●	
AutoTrac RowSense™	●		
APPLICATION			
Harvest Monitor™	●	●	
GreenStar™ Rate Controller: Multiple Product	●		
GreenStar™ Rate Controller: Single Product	●	●	
SprayStar™	●	●	
SeedStar™	●	●	
SpreadStar™	●	●	
iSteer™	●		
iGrade™	●		

GUIDANCE

Guidance Type	Benefits	Accuracy
Parallel Tracking	High value, low-cost manual guidance system – perfect for tillage, chemical applications, fertilizer treatments, or harvesting.	+/- 13 inch pass-to-pass
SF1	Hands-free assisted steering that reduces operator fatigue, boosts pass-to-pass accuracy, reduces inputs, and lets you operate at fast speeds, at night, or in low visibility conditions.	+/- 10 inch pass-to-pass
SF2	Hands-free assisted steering that reduces operator fatigue, boosts pass-to-pass accuracy, reduces inputs, and lets you operate at fast speeds, at night, or in low visibility conditions.	+/- 4 inch pass-to-pass
RTK	Hands-free assisted steering that reduces operator fatigue, boosts pass-to-pass accuracy, reduces inputs, and lets you operate at fast speeds, at night, or in low visibility conditions.	One-inch, repeatable
Integrated AutoTrac™	Integrated AutoTrac vehicle kits provide automatic guidance on newer John Deere vehicles. Pair integrated AutoTrac with your desired signal level (SF1, SF2, or RTK) for optimal accuracy, without sacrificing cab space. You'll get precision guidance that reduces operator fatigue, boosts pass-to-pass accuracy, reduces inputs, and lets you operate more efficiently in a variety of conditions.	Dependent on signal used
AutoTrac™ Controller	AutoTrac Controller is an integrated automatic guidance option for select non-John Deere tractors. It allows you to take advantage of all the in-field benefits of integrated AutoTrac.	Dependent on signal used
AutoTrac™ Universal	The AutoTrac Universal steering kit is used for automatic guidance in older John Deere or non-John Deere vehicles. Its use helps reduce operator fatigue, boost pass-to-pass accuracy, reduces inputs, and lets you operate more efficiently in a variety of conditions..	Dependent on signal used

INFORMATION MANAGEMENT

Farm and Fleet Management	Description
Apex™	Open architecture farm management software specifically designed for precision ag data and systems.
JDLink™ Select	All-makes, all-model telematics, web-based fleet management application compatible with 12- or 24-V power source.
JDLink™ Ultimate	JDLink Ultimate offers the same features as JDLink Select, as well as advanced functionality, including remote diagnostics. It is available on 30 Series Tractors, new Model Year 2011 8R Tractors, and 7X50 Series Self-Propelled Forage Harvesters.

DOCUMENTATION

Documentation Applications	Description
Field Doc™ Basic	Collect and record data about field conditions, tillage practices, fertilizer rates, seed varieties and populations, weather conditions, and more.
Map Based Prescriptions	Lets you use soil analysis data, elevation maps, yield summaries, and more to create field-specific farming prescriptions. Then you can better place inputs, and get more from every acre.
Harvest Doc™	For 60 and 70 Series Combines, also compatible with 00, 10, and 50 Series Combines with upgrades. Collect and map raw yield, moisture, and position data. Record field boundaries, loads, field conditions, and weather, as well as machine and operator productivity. Compatible with all GreenStar applications including Parallel Tracking and AutoTrac.
HarvestLab™	Precisely measures forage crop moisture at harvest.

Δ See your John Deere Dealer for a list of compatible older-model GreenStar™ Displays.
*Certain receivers may not have the compatibility required for certain Pro Modules and applications. Please see your dealer for more information on receivers.
± GLONASS is the Russian satellite constellation. It is in base on the StarFire™ 3000 Receiver and is only compatible with RTK accuracy at this time. Additional signals will become available in 2011.

GS3 2630

GS2 1800

GS Lightbar

StarFire™ 3000 and StarFire™ RTK Radio

StarFire™ 300

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*Subject to John Deere Credit Approval

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DSAA45790 Litho in U.S.A. (10-08)

SSI Technologies – Application Note PS-AN2

MediaSensor™ Absolute, Sealed, Gage Pressure Sensors

Family Product Overview

Product Description

The MediaSensor™ (P51) family of bulk micro-machined, absolute, sealed and gage pressure sensors are for both harsh and benign media with superior *accuracy over an operating temperature of -40°C to 105°C.* These compact, robust sensors measure pressures from 3 PSI to 5,000 PSI and are well suited for a variety of automotive, industrial and commercial applications.

Product Features

- **Superb Accuracy:**
  - +/- 0.5% Full Scale for 75 PSI to 5000 PSI
  - +/- 1% Full Scale for 15 PSI to 60 PSI
  - +/- 2% Full Scale for 3 PSI to 10 PSI
- **Pressure Ranges**: 3 PSI to 5,000 PSI
- **Electronics:**
  - 0.5 – 4.5 Volt output (with 5V input)
  - 0.5 – 4.5 Volt output with overvoltage protection (with 5V input)
  - 1-5 Volt output (with 8 - 30V input)
  - 4 – 20 mA output (with 8 - 30V input)
- **Temperature Range:** -40°C to 105°C
- **Maximum Flexibility**: Custom ASIC provides signal conditioning for calibration and temperature compensation.
- **Standard and custom options available for OEM quantities**
- **Excellent price/performance ratio**

MediaSensor™ *Family of Pressure Sensors with integrated signal conditioning*

- **Compact, Robust Package:** All laser-welded stainless steel design for optimal media isolation in compact size
- **Chemical Compatibilities:** Any gas or liquid compatible with 304L & 316L Stainless Steel. For example, Motor Oil, Diesel, Hydraulic fluid, brake fluid, water, waste water, Hydrogen, Nitrogen, and Air.
- **Typical Applications**: Refrigeration; Fuel Cells; Pumps; Hydraulics; Process Control; Spraying Systems; Pneumatics; Compressors; Flow; Robotics; Agriculture; Hydrogen Storage

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or visit our **Website:**

http://ssitechnologies.com

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SSI Technologies – Application Note PS-AN2

MediaSensor™ Absolute, Sealed, Gage Pressure Sensors

Family Product Overview

Standard Full Scale Pressure Ranges

- **Gage:** 3, 5,10, 15, 25, 30, 50, 60, 75, 100, 120, 130, 200, 225, 250 and 300 PSIG
- **Sealed:** 50, 100, 150, 200, 300, 400, 500, 750, 1000, 1500, 2000, 3000 and 5000 PSIS
- **Absolute:** 15, 30, 50, 65, 75, 100, 150, 200, 250, 300, 500, 750, 1000, 1500, 2000, and 3000 PSIA

Measurement Technology

In general, pressure measurement technology translates force from an induced pressure into an electrical quantity. The MediaSensor™ family of pressure transducers and transmitters use piezoresistive technology for its sensor signal processing to measure pressure.

A micro-machined stainless steel convoluted diaphragm with a silicon crystal semiconductor is used. Strain gauges (resistive elements) in the silicon crystal are used in a Wheatstone Bridge circuit. When pressure is applied, the resistivity of the strain gauges changes proportional to the pressure applied. Since a single silicon crystal is used it has a low mechanical hysteresis with good linearity.

One leg of the bridge measures the input pressures port. The other leg of the bridge is connected to the reference port the input pressure port is compared to. The connection to this reference port determines the pressure sensing convention used.

The MediaSensor™ family comes in a choice of three pressure sensing type conventions: absolute, gauge (vented or sealed).

Absolute MediaSensors™ measure pressure relative to perfect Vacuum pressure (0 PSI) which remains unchanged regardless of temperature, location or other ambient conditions such as weather. Absolute MediaSensors™ are calibrated to have 0.5 Vdc, 1 Vdc, or 4 mA respectively at 0 PSIA.

There are two different gauge pressure conventions – Vented Gauge and Sealed Gauge. Gauge MediaSensors™ measure pressure relative to ambient room pressure through a port that is vented (open) to the atmosphere. Gauge MediaSensors™ are calibrated to have 0.5 Vdc, 1 Vdc, or 4 mA respectively at 0 PSIG.

Sealed MediaSensors™ measure pressure relative to a port that is connected to a sealed perfect vacuum chamber. Sealed MediaSensors™ are calibrated to 14.5 PSI absolute. Sealed MediaSensors™ are calibrated to have 0.5Vdc, 1 Vdc, or 4 mA respectively at 14.5 PSIA.

The MediaSensor™ takes the two voltage output ports of the Wheatstone bridge and amplifies the signal. Piezoresistive pressure sensors are sensitive to changes in temperature. The MediaSensor™ uses signal conditioning to compensate for temperature and calibration. The output signal is then converted into one of four forms:

1) 0.5 – 4.5 Volt ratiometric output (transducer)
2) 0.5 – 4.5 V ratiometric output with Overvoltage protection (transducer)
3) 1 – 5 volt output (transducer)
4) 4 – 20 mA output (transmitters)

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Ratiometric outputs vary as a ratio of the supply voltage.

Transmitters are very suitable in applications that use long cables. There is virtually no error from voltage drop introduced from the wire resistance when sending the signal as a current. They are also less sensitive to electromagnetic interference.

Some piezoresistive pressure transducers use only an unprotected silicon sensing element. Silicon is a brittle crystalline material, which can sometimes crack under severe cold transient environments. The MediaSensor™ pressure transducer uses an additional 316L stainless steel convoluted diaphragm with a protective non-silicone oil to protect the sensitive silicon sensing element from the harsh media and environmental conditions. The 316L stainless steel diaphragm not only provides for optimal water and chemical media isolation for the silicon crystal sensing element but can handle cold temperature transients without sustaining damage.

Under cold transient conditions and within our operating temperature range, the oil does not gel and acts as a buffer for the silicon sensing element from the extreme temperature transients found in certain applications such as refrigeration.

MediaSensor™ Compensations Features

All the compensation circuitry is internal to the MediaSensor™ pressure transducer. No external compensation modules are needed.

1) Zero balancing (Null Offset) Calibration

During manufacturing the Wheatstone Bridge resistive elements are closely matched and compensated, however an offset voltage (due to resistance differences) may still exist. SSI MediaSensor™ compensates for this offset over operating temperature range (refer to Table 1).

2) Span Calibration

The resistance of silicon gauges is temperature dependent. The span will shift with temperature to a final stabilized value as it warms up. SSI MediaSensor™ compensates for this span variation over operating temperature range.

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MediaSensor™ Absolute, Sealed, Gage Pressure Sensors

Family Product Overview

Typical Connections

The following torque limits should be used when mounting the MediaSensor™ pressure port.

Straight Thread w/O-Ring:	**Recommended Torque**
High Pressure (> 750 PSI)	300 in lb
All others with out Port types T, U, Y	150 in lb
Parts with Ports T,U, Y	120 in lb
NPTF Thread:	2 T.F.F.T. (Turns From Finger Tight)

MediaSensor™ 4 -20mA Output connections:

1) Connect the Power Lead (Red) to the + terminal of the supply voltage.
2) Connect the Return Lead (White) to the + terminal of the current measuring device
3) Connect the – terminal of the current measuring device to the – terminal of the supply voltage.

MediaSensor™ Voltage Output connections:

1) Connect the Power Lead (Red) to the + terminal of the supply voltage.
2) Connect the Ground Lead (Black) and the – terminal of the supply voltage to – input of your voltage measurement equipment.
3) Connect the Vout Lead (White) to the + input of your voltage measurement equipment.

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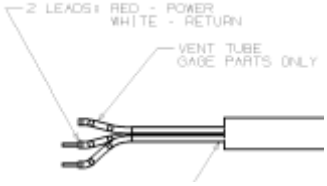
MediaSensor™ Absolute, Sealed, Gage Pressure Sensors

Family Product Overview

Packaging

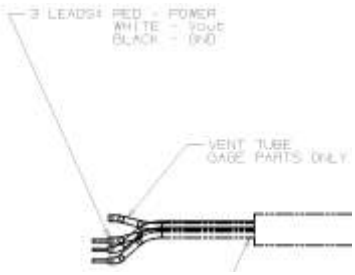
MediaSensor™ is readily available in a large selection of standard packaging options. MediaSensor™ offers an integral harness with 6 standard lengths and four standard readily available connectors (Packard, Deutsch, M12 and Mini DIN). In addition, SSI will work with the customer to meet their needs with custom options for large volumes orders. (I.e... special fittings & connectors; special pressure ranges; operating temperature; and increased accuracy).

Integral Harness (Standard lengths of 6", 12", 18", 24", 36" and 72"). The Harness can be constructed of either PVC Jacketed 18 or 24 AWG Wire.



Wire Color
Red - Power
White - Return

Integral Harness Transmitter (4 to 20 mA)



Wire Color
Red - Power
White - Vout
Black - Ground

Integral Harness Transducer(1 to 5 Vdc or 0.5 to 4.5Vdc)

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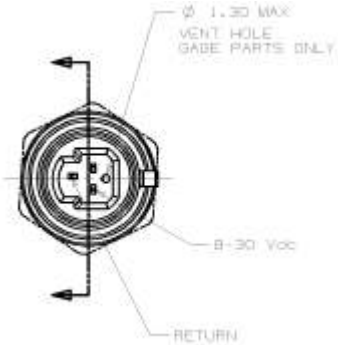
MediaSensor™ Absolute, Sealed, Gage Pressure Sensors

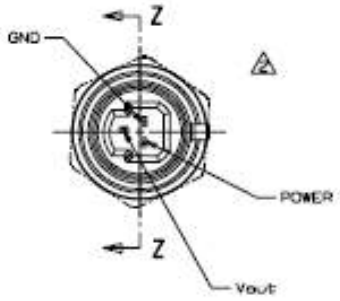
Family Product Overview

Standard Connector Options



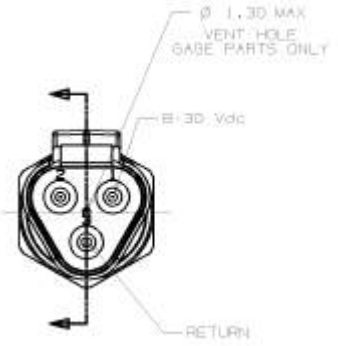
Pin 1 - Power
2 - Not Used
3 - Return

Packard Connector Transmitter (4 to 20 mA)



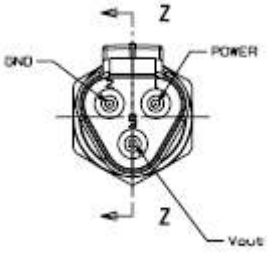
Pin 1 - Power
2 - Ground
3 - Vout

Packard Connector Transducer (1 to 5 Vdc or 0.5 to 4.5Vdc)



Pin 1 - Power
2 - Not Used
3 - Return

Deutsch Connector Transmitter (4 to 20 mA)



Pin 1 - Power
2 - Ground
3 - Vout

Deutsch Connector Transducer (1 to 5 Vdc or 0.5 to 4.5Vdc)

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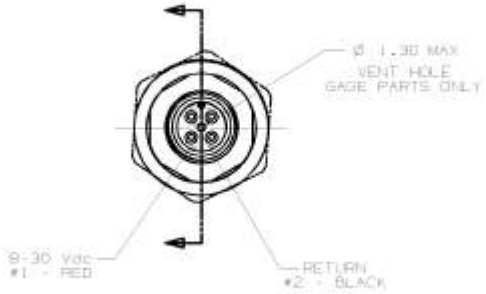
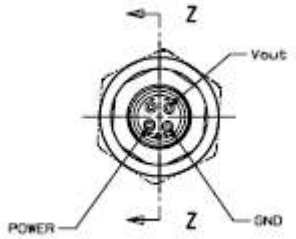
MediaSensor™ Absolute, Sealed, Gage Pressure Sensors

Family Product Overview



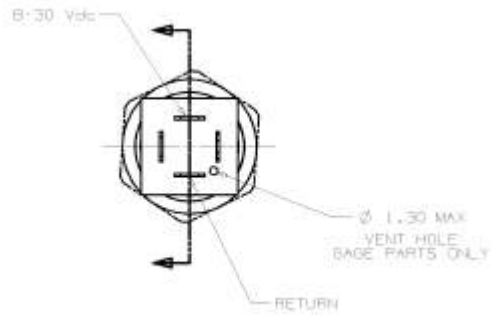
Pin 1 - Power
2 - Return
3 – Not Used
4 – Not Used

M12 Connector Transmitter (4 to 20 mA)



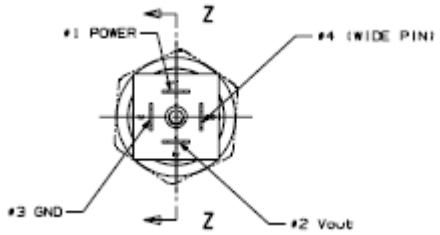
Pin 1 - Power
2 - Ground
3 – Vout
4 – Not Used

M12 Connector Transducer (1 to 5 Vdc or 0.5 to 4.5Vdc)



Pin 1 - Power
2 - Return
3 – Not Used
4 – Not Used

DIN 43650 Transmitter Connector



Pin 1 - Power
2 - Vout
3 – Ground
4 – Not Used

DIN 43650 Transducer Connector

SSI TECHNOLOGIES, INC.
Controls Division
2643 W. Court Street
Janesville, WI 53548-5011
Phone: (608)758-1500 Fax: (608) 758-2491
www.ssitechnologies.com

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Revision 3

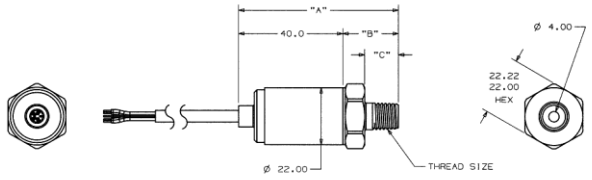
CE ISO 9001 CERTIFIED QUALITY MANAGEMENT SYSTEM RoHS

SSI Technologies – Application Note PS-AN2

MediaSensor™ Absolute, Sealed, Gage Pressure Sensors

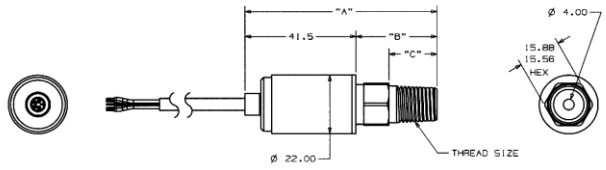
Family Product Overview

Standard Packaging Options



THREAD SIZE	LENGTH "A"	LENGTH "B"	LENGTH "C"
1/4-18 NPT	66.6	26.0	18.0
1/8-27 NPT	61.6	21.0	13.0
M12-1.5 6g	59.6	19.0	11.0
7/16-20 UNF	59.6	19.0	11.0
3/8-24 UNF	58.1	17.5	9.5

Integral Harness with 22mm Hex



THREAD SIZE	LENGTH "A"	LENGTH "B"	LENGTH "C"
1/4-18 NPT	72.0	30.5	18.0
1/8-27 NPT	67.0	25.5	13.0
M12-1.5 6g	65.0	23.5	11.0
7/16-20 UNF	65.0	23.5	11.0
3/8-24 UNF	63.5	22.0	9.5

Integral Harness with 5/8" Hex

Harness Construction: PVC Jacketed 18 or 24 AWG Wire

Please visit our website at http://www.ssitechnologies.com for a more information and a listing of all the series of pressure sensors in the MediaSensor™ family or call SSI toll-free at **1- 888- 477- 4320**

SSI TECHNOLOGIES, INC.
Controls Division
2643 W. Court Street
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Revision 3

CE ISO 9001 CERTIFIED QUALITY MANAGEMENT SYSTEM RoHS

Representative photo only

Cole-Parmer High-Accuracy Pressure Transducers - 0 to 50 psig Cole-Parmer® ±0.25%-Accuracy Gauge Transmitter, 0.5 to 5.5 V Output

Specifications

Product Type	Pressure transducers
Wetted materials	17-4 PH SS
Temp range (compensated)	-4° to 176°F (-20° to 80°C)
Accuracy	±0.25% full-scale
Range	0 to 50 psi
Output	0.5 to 5.5 V
Process connection	1/4" NPT(M)
Electrical connections	2-ft (0.6-m) cable
Power	9 to 30 VDC
CE Compliance	Yes
Brand	Cole-Parmer
Manufacturer number	2091-050P-G-2M-24-02-CP1

Cole-Parmer Canada Inc.
210-5101 Buchan St. Montreal, QC H4P 2R9 Canada
Phone: 514-355-6100 Fax: 514-355-7119 e-mail: info@Coleparmer.ca
Cole-Parmer Web Sites: United States|Canada|China|United Kingdom|India

Extract from the online catalog

RAD-ISM-900-RX

Order No.: 2867047

http://eshop.phoenixcontact.ca/phoenix/treeViewClick.do?UID=2867047

Receiver to expand point-to-multipoint connections, for unidirectional wireless 900 MHz transmission system (America)

Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation at http://www.download.phoenixcontact.com. The General Terms and Conditions of Use apply to Internet downloads.

Commercial data

EAN	4 017918 929589
Pack	1 pcs.
Customs tariff	85389091
Catalog page information	Page 668 (IF-2011)

Technical data

Wireless path

Direction	Uni-directional
Frequency range	902 MHz ... 928 MHz
Number of channel groups	4
Number of channels per group	63

Analog output (receiver)

Output name	Current output
Current output signal	4 mA ... 20 mA
Load/output load current output	700 Ω (at U_B = 24 V, R_B = [U_B-10 V] / 20 mA)

Digital output (receiver)

Output name	2 x relay output + 1 x RF link

Contact type	3 floating PDT contacts
Contact material	Ag, gold-plated
Maximum switching voltage	30 V DC
	120 V AC
Limiting continuous current	0.5 A
Mechanical service life	1×10^7
Service life, electrical	8×10^5 cycles at a switching current of 0.5 A

Supply (receiver)

Supply voltage	24 V DC (at U_B)
Supply voltage range	12 V DC ... 30 V DC
Typical current consumption	85 mA
Max. current consumption	125 mA

General data

Width	17.5 mm
Height	99 mm
Depth	114.5 mm
Ambient temperature (operation)	-40 °C ... 70 °C
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Mounting position	Any
Assembly instructions	on standard DIN rail NS 35 in accordance with EN 60715
Housing material	Polyamide PA non-reinforced
Conformance	FCC Directive, Part 15.247
	ISC Directive RSS 210
UL, USA / Canada	Class I, Div. 2, Groups A, B, C, D

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	2.5 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	2.5 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	14
Connection method	Screw connection
Stripping length	8 mm
Screw thread	M3

Address

PHOENIX CONTACT Ltd
8240 Parkhill Drive
Milton, Ontario L9T 5V7,Canada
Phone (800) 890-2820
Fax (905) 864-7900
http://www.phoenixcontact.ca

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Extract from the online catalog

RAD-ISM-900-TX-DC

Order No.: 2867348

http://eshop.phoenixcontact.ca/phoenix/treeViewClick.do?UID=2867348

Transmitter as replacement device, for unidirectional, wireless 900 MHz transmission system (America)

Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation at http://www.download.phoenixcontact.com. The General Terms and Conditions of Use apply to Internet downloads.

Commercial data

Pack	1 pcs.
Customs tariff	85299072

Certificates

Certification Ex: CUL-EX LIS, UL-EX LIS

Accessories

Item	Designation	Description
Cable/conductor		
2867238	RAD-CAB-LMR400-100	Antenna extension cable, length: 100 ft
2867380	RAD-CAB-LMR400-60	Antenna extension cable, length: 60 ft
2867393	RAD-CAB-LMR400-80	Antenna extension cable, length: 80 ft
2885184	RAD-CAB-LMR600-150	Antenna extension cable, length: 150 ft
2885197	RAD-CAB-LMR900-200	Antenna extension cable, length: 200 ft
2867597	RAD-CAB-RG213-25	Antenna extension cable, length: 25 ft
2867377	RAD-CAB-RG213-40	Antenna extension cable, length: 40 ft
2867225	RAD-CAB-RG213-50	Antenna extension cable, length: 50 ft

2867364	RAD-CAB-RG58-10	Antenna extension cable, length: 10 ft
2867212	RAD-CAB-RG58-20	Antenna extension cable, length: 20 ft

General

2867050	RAD-ISM-900-ANT-4	4-way distributor for antenna signals (antenna splitter), MCX connection (female)
2867160	RAD-ISM-900-ANT-OMNI-0-6	Omnidirectional antenna, IP65 protection, cable length 2 m, connection MCX (male)
2867199	RAD-ISM-900-ANT-OMNI-5	Omnidirectional antenna, IP65 protection, gain 7 dBi, connection N (female)
2867791	RAD-ISM-900-ANT-OMNI-FG-3-N	Omnidirectional antenna, IP65 protection, gain 5 dBi, connection N (female)
2885579	RAD-ISM-900-ANT-OMNI-FG-6-N	Omnidirectional antenna, IP65 protection, gain 8 dBi, connection N (female)
2867801	RAD-ISM-900-ANT-YAGI-3-N	Panel antenna, IP65 protection, gain 5 dBi, cable length 1.5 m, connection N (female)
2867827	RAD-ISM-900-ANT-YAGI-6.5-25-AS	Panel antenna with surge protection, adapter cable MCX->N and assembly material, IP65 protection, gain 8.5 dBi, cable length 7.6 m, connection N (female)
2867830	RAD-ISM-900-ANT-YAGI-6.5-50-AS	Panel antenna with surge protection, adapter cable MCX->N and assembly material, IP65 protection, gain 8.5 dBi, cable length 15.2 m, connection N (female)
2867814	RAD-ISM-900-ANT-YAGI-6.5-N	Panel antenna, IP65 protection, gain 8.5 dBi, cable length 1.5 m, connection N (female)

Plug/Adapter

2867607	RAD-CON-MCX-MCX-SS	Adapter cable, pigtail 30 cm SMA (m) -> N (m)
2867717	RAD-CON-MCX-N-SB	Adapter cable, pigtail 120 cm MCX(m) -> N(f)
2885621	RAD-CON-MCX-RPSMA-EX	Adapter cable for Ex zone 1, pigtail 90 cm MCX (m) -> RPSMA (m)
2885207	RAD-CON-MCX90-N-SS	Adapter cable, pigtail 120 cm 90° MCX(m) -> N(m)
2867403	RAD-CON-SMA-N-SS	Adapter cable, pigtail 120 cm SMA(m) -> N(m)

Address

PHOENIX CONTACT Ltd
8240 Parkhill Drive
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Fax (905) 864-7900
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Extract from the online catalog

RAD-ISM-900-RS232-BD

Order No.: 2867555

http://eshop.phoenixcontact.ca/phoenix/treeViewClick.do?UID=2867555

Wireless transceiver (transmitter and receiver) with RS-232 interface, for 900 MHz ISM band (America)

Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation at http://www.download.phoenixcontact.com. The General Terms and Conditions of Use apply to Internet downloads.

Commercial data	
Pack	1 pcs.
Customs tariff	85389091
Catalog page information	Page 673 (IF-2011)

Technical data

Wireless set

Set contents	1 transceiver

Wireless path

Direction	Bi-directional
Frequency range	902 MHz ... 928 MHz
Transmission power	1 W
Number of channel groups	4
Number of channels per group	63

Serial interface

Name	RS-232
Data rate	1,2 / 2,4 / 9,6 / 19,2 / 38,4 kBit/s
Connection method	9-pos. D-SUB (female connector)
File format/coding	Asynchronous
Data flow control/protocols	RTS/CTS

Supply	
Supply voltage	24 V DC
Supply voltage range	9 V DC ... 30 V DC
Typical current consumption	110 mA
Max. current consumption	180 mA

General data	
Width	22.5 mm
Height	75 mm
Depth	107.5 mm
Ambient temperature (operation)	-40 °C ... 70 °C
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Degree of protection	IP20
Mounting position	Any
Assembly instructions	on standard DIN rail NS 35 in accordance with EN 60715
Housing material	Polyamide PA non-reinforced
Conformance	FCC Directive, Part 15.247
	ISC Directive RSS 210
UL, USA / Canada	Class I, Div. 2, Groups A, B, C, D

Connection data	
Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	4 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	2.5 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	12
Connection method	Screw connection
Stripping length	8 mm
Screw thread	M3

Address

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8240 Parkhill Drive
Milton, Ontario L9T 5V7,Canada
Phone (800) 890-2820
Fax (905) 864-7900
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pn#7011-rev000

Model IC820A

Universal Converter

Covers All the Bases: RS-232 to 4-wire RS-422, 2-wire or 4-wire RS-485

Highlights

- Selectable RS-485 2-wire half-duplex, or RS-485 4-wire full-duplex operation
- Selectable RS-422 operation - Transmit & Receive always enabled
- DB9 Female RS-232 Connection, Terminal Blocks for RS-422/RS-485
- Port power or External 12V DC power (jack)
- Automatic RS-485 Driver Control - works without special programming
    - Enables Transmitter from RS-232 TD signal
    - Enables Receiver when not Transmitting (half duplex)
- Built-In bridging switches for 2-wire or 4-wire modes – no external jumpers
- Operating Mode Switches: 4
    - Transmit mode, Receive Mode, and 2 switches for 4-Wire or 2-Wire
    - Receiver mode: Echo On (4-wire) or Echo Off (2-wire RS-485)
    - Two 4-wire/2-wire switches for full or half duplex (bridge) connections

Description

The IC820A Universal Converter provides RS-232 to RS-422/RS-485 conversion using either port-power or an external power supply. Data is converted in both directions, RS-232 Transmit data is converted to balanced RS-422 or RS-485 Transmit, and Received RS-422/RS-485 signals are converted to RS-232. Unlike converters, which require programming hardware handshaking signals to control RS-485 or RS-422 operation, the IC820A provides automatic control. In RS-485 mode, the RS-485 driver is enabled by circuitry, which senses the RS-232 TD input. In half duplex RS-485 mode, the receiver is enabled when not transmitting. For full duplex operation, the receiver is set always enabled. In RS-422 mode, the transmitter and receiver are always enabled. The operating mode is set with 4 switches (Table 1). The RS-232 signal lines power the IC820A whether they are set high or low. If not enough power is available from the port, or no handshaking lines are available, a DC jack is provided to connect a 12VDC supply. The DB9 female connector for RS-232 is wired as DCE (like a modem).

Power

No external power is required if two RS-232 output handshake lines (RTS & DTR) are available and the cable run is short. If the handshake lines are raised (enabled) and no termination is used, the power efficiency is greatly increased. Less than 3mA is required to operate the IC820A plus the load current. For applications that do not have handshake lines or require a large load current, power may be externally supplied with a +12VDC power supply with a 2.5mm plug (tip positive).

RS-232 Operation

RS-232 connections require pins 2 (RD), 3 (TD), and 5 (Signal Ground). Pins 7 (RTS) and 8 (CTS) are tied together, and pins 6 (DSR), 1 (DCD), and 4 (DTR) are also tied together. Any incoming data lines in either the high or low state are used to port power the IC820A. The more handshake lines available, the more likely the unit can be port powered. Table 2 shows the RS-232 pinout.

Refer to matching Figures 1 to 4 for each mode for typical connections. See Table 1, and set Switches 1-4 to match the Operating Mode. See Troubleshooting section for Loopback Test Mode.

Table 1 – Switch Settings for Operating Mode

Switches	Switch 1 (Tx)	Switch 2 (Rx)	Switch 3 (bridge)	Switch 4 (bridge)
Operating Mode				
RS-485 2-Wire Mode (half duplex)	RS-485	Echo Off	2-Wire	2-Wire
RS-485 4-Wire Mode (full duplex)	RS-485	Echo On	4-Wire	4-Wire
RS-422 4-Wire Mode (full duplex)	RS-422	Echo On	4-Wire	4-Wire
Loopback Test Mode*	As Desired	Echo On	2-Wire	2-Wire

** Used with HyperTerminal or another Terminal program to confirm operation of data through converter*

Figure 1: 2-Wire RS-485

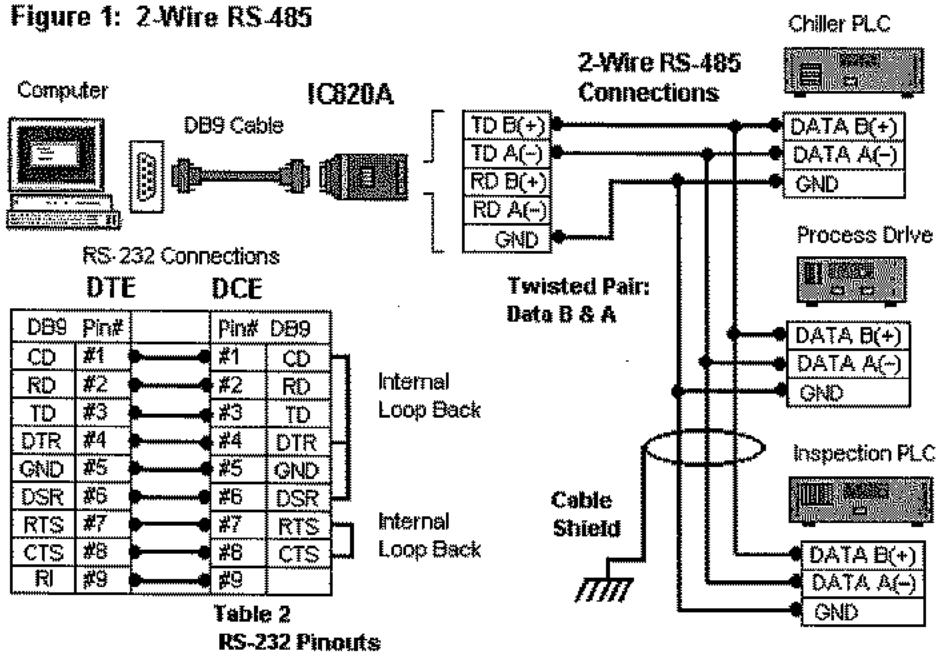


Table 2
RS-232 Pinouts

Figure 2: 4-Wire RS-485

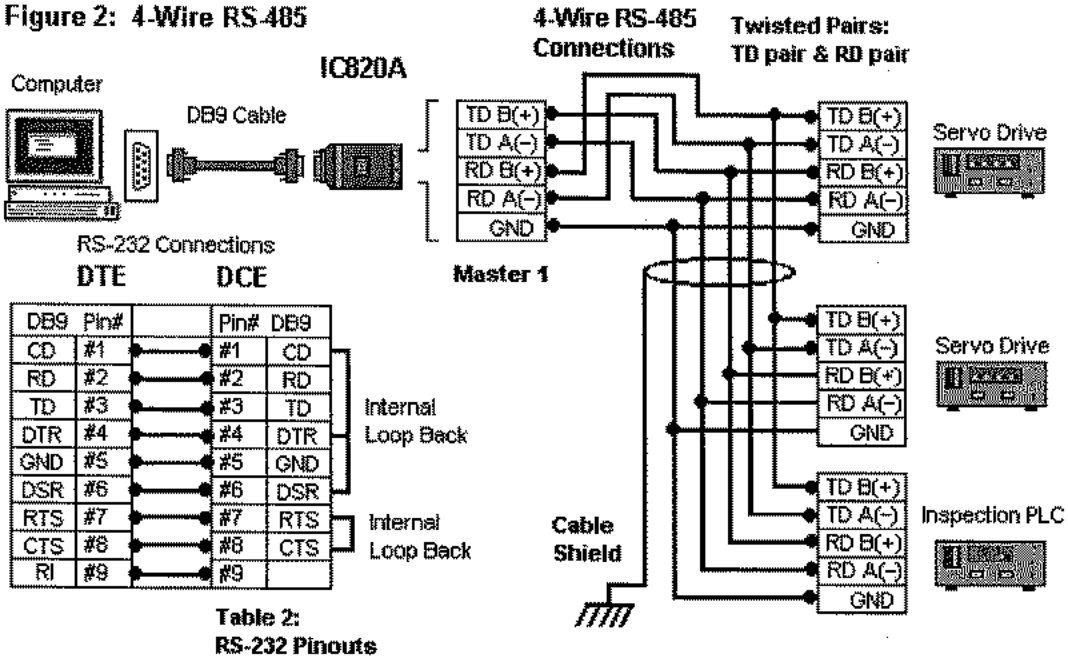
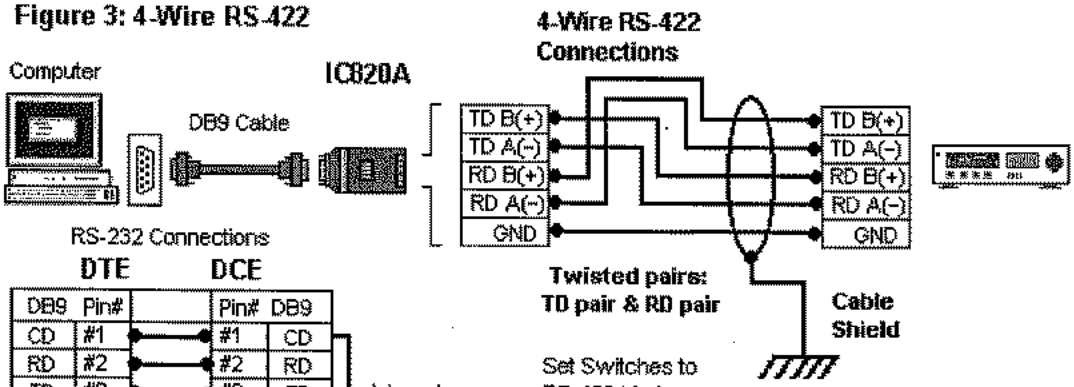


Table 2:
RS-232 Pinouts

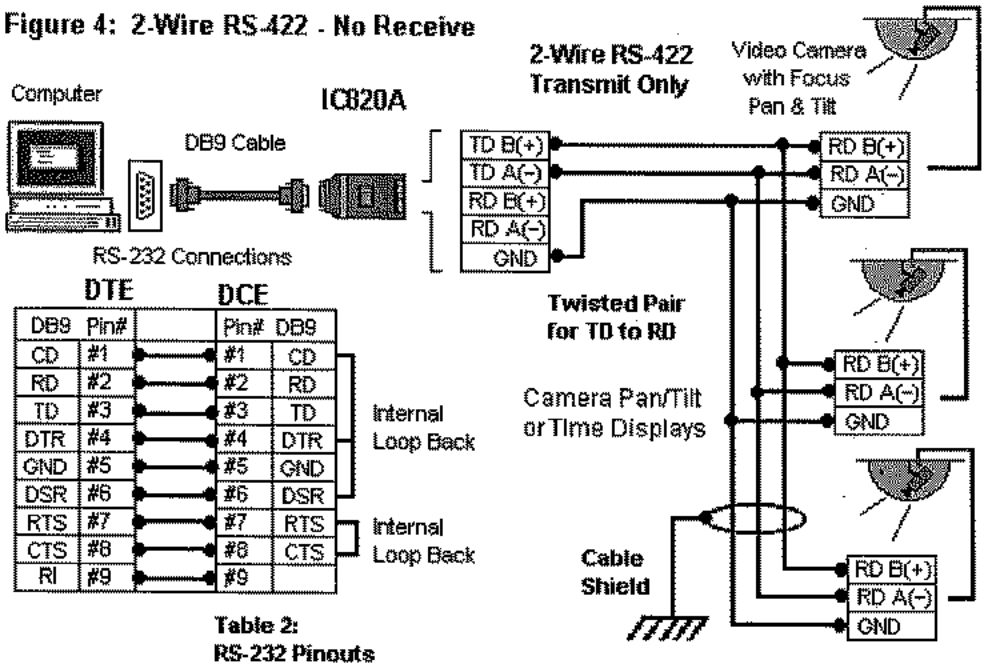
Figure 3: 4-Wire RS-422



DB9	Pin#		Pin#	DB9
CD	#1		#1	CD
RD	#2		#2	RD
TD	#3		#3	TD
DTR	#4		#4	DTR
GND	#5		#5	GND
DSR	#6		#6	DSR
RTS	#7		#7	RTS
CTS	#8		#8	CTS
RI	#9		#9	

Table 2: RS-232 Pinouts

Figure 4: 2-Wire RS-422 - No Receive



DB9	Pin#		Pin#	DB9
CD	#1		#1	CD
RD	#2		#2	RD
TD	#3		#3	TD
DTR	#4		#4	DTR
GND	#5		#5	GND
DSR	#6		#6	DSR
RTS	#7		#7	RTS
CTS	#8		#8	CTS
RI	#9		#9	

Table 2: RS-232 Pinouts

RS-422/485 Operations

The RS-422 standard was designed to extend RS-232 connections, the RS-485 standard is an enhanced version which allows multiple drivers/receivers to alternately share one pair of wires for transmit and receive, or two pairs for full duplex operation. With a RS-485 device, the transmitter/driver is only active while transmitting, but when not transmitting, is set to a high impedance state, which allows another transmitter to send data on the same wire pair. In the IC820A, the driver is controlled by circuitry, which senses the RS-232 TD input, and automatically enables transmit. In half duplex operation, the receiver is enabled when not transmitting (Echo Off).

The IC820A does not require any handshaking lines to control the driver in RS-422 or RS-485 mode. When Switch 1 set to RS-422, the driver is always enabled. When switch 1 is in the RS-485 position, the RS-485 driver is automatically enabled during each Space state by the RS-232 data. During the Mark or idle state, the RS-485 driver is disabled and the data lines are held in the Mark state by Bias provided by the 4.7K Ohm pull-up and pull-down resistors. The value of these resistors may need to be changed to a different value when termination is used in order to maintain the proper DC bias during the idle state.

RS-485 2-Wire Half Duplex

This communications mode is used to connect several RS-485 devices to the same network with a minimum number of wires when only one unit talks at a time. All units are normally in Receive mode, listening for data. When data is requested, the addressed device waits (1 delay time) then transmits, afterwards, goes back to receive. To use this mode set Switch 1: RS-485 , Switch 2: Echo Off, and Switches 3 and 4 to 2-Wire. Refer to Figure 1 for connections.

RS-486 4-Wire Full Duplex

This mode is used for 4-Wire Master/Slave. Devices can be polled and respond faster, unlike half duplex mode, no turn-around time delay is needed between requests and responses. The RS-485 driver works the same as in haft duplex but the receiver is always enabled. This can allow devices to receive information even while they are responding to a request. To use RS-485 4-Wire mode, set Switch 1: RS-485, Switch 2: Echo On, and Switches 3 and 4 to 4-Wire. When the IC820A is used as a Master in a single master system, Switch 1 can be set RS-422 since it is the only transmitter. When used for a Slave device, the RS-232 device must provide addressability, and RS-485 mode should be selected. As in 2-Wire operation RS-485 Biasing is provided on Receive, and should be provided on the transmit pair by the End-of-Line slave device, RS-422 Transmit mode requires no bias on transmit. Refer to Figure 2 for Connections

RS-422 4-Wire Full-Duplex or 2-Wire Simplex

This communications mode is typically used for point-to-point communications over long distances with better noise immunity than RS-232. Another common use is as a single master in a master/slave configuration, where the slave devices only receive, but don't transmit back. In RS-422 the transmitter and receiver are always enabled to allow full-duplex communications. Connections require one twisted pair for Transmit, another twisted pair for Receive and a ground reference wire for a total of 5 lines to operate properly. To set this mode, Table 1: Switch 1: RS-422, Switch 2: Echo On, and Switches 3 and 4: 4-wire.

Specifications

- Signals:
  - Transmit (TD) and Receive (RD)
  - RTS and CTS are looped back, DTR., DSR & CD are looped back
- Data Rates:
  - Up to 115.2 kbps
- Distance:
  - Externally powered transmits up to 4000 ft (1200 m) at 115.2 kbps (may be less with port powering)
- Dimensions:
  - 3.6 x 1.7 x 0.9 in (9.0 x 4.3 x 2.3 cm)
- Temperature:
  - 0-70°C

Troubleshooting Operation

If an RS-485 or RS-422 device doesn't respond to data requests, try swapping the polarity of the data lines. Some devices are marked opposite the RS-485 or RS-422 Standard.. 4-Wire devices must swap polarity of each pair. Operation of the converter can be checked with HyperTerminal. Set Converter to Loopback Test mode. Open HyperTerminal using the COM port connected to, set baud rate, set Flow Control to None, type characters. Each character should show as typed, two if local echo is on. For more info, visit our website, Technical Library, FAQ on Troubleshooting and Checking.

OECLARATION OF CONFORMITY

Model Number	IC820A
Description:	RS-422/485 Converter
Type:	Light industrial ITE equipment
Application of Council Directive:	89/336/EEC
Standards:	EN 55022 EN 61000-6-1 EN 61000 (-4-2, -4-3, -4-4, -4-5, -4-6, -4-8, -4-11)

CE

Overview

With the SVX9000 series sensorless vector control, Eaton's expanded Cutler-Hammer® drive offering now covers a complete line of PWM adjustable frequency (speed) drives in ratings from:

- 208V — 3/4 to 100 hp I_H; 1 to 100 hp I_L
- 230V — 3/4 to 100 hp I_H; 1 to 100 hp I_L
- 480V — 1 to 1900 hp I_H; 1-1/2 to 2200 hp I_L
- 575V — 2 to 2000 hp I_H; 3 to 2300 hp I_L

The 9000X Family of Drives includes HVX9000, SVX9000, SLX9000 and SPX9000 drives. 9000X Series drive ratings are rated for either high overload (I_H) or low overload (I_L). I_L indicates 110% overload capacity for 1 minute out of 10 minutes. I_H indicates 150% overload capacity for 1 minute out of 10 minutes.

A full range of enclosure types and options are available to meet a wide array of applications — from simple variable torque to more complex industrial applications such as conveyors, mixers and machine controls.

Application Description

Application Engineering

Proper selection and application of all drive system components is essential to assure that an adjustable frequency drive system will safely and reliably provide the performance required for any given application. The party responsible for the overall design and operation of the facility must make sure that qualified personnel are employed to select all components of the drive system, including appropriate safety devices. Eaton's Cutler-Hammer AF Drives Application Engineering Department is prepared to provide assistance to answer any questions about the technical capabilities of Cutler-Hammer drives.

Motor Selection

The basic requirement of motor selection is to match the torque vs. speed capability of the motor to the torque vs. speed requirement of the driven load.

Motor Torque vs. Speed Capability

As the speed of a motor is reduced below its 60 Hz base speed, motor cooling becomes less effective because of the reduced speed of the self-cooling fan. This limitation determines the maximum torque for continuous operation at any operating speed. The maximum intermittent operating torque is determined by the motor's torque vs. current characteristics and the output current capability of the adjustable frequency controller.

Multiple Motor Operation

A number of motors can be connected in parallel to a single controller. Since the frequency of the power supplied by the controller is the same for each motor, the motors will always operate at the same speed. Application Engineering assistance must be requested for all multiple motor applications to assure compliance with all controller design limitations.

Special Types of Motors

Standard NEMA Designs A and B three-phase motors are the only motors recommended for use in the majority of applications, but other types of motors are occasionally used. If the existing motor used in the application or the motor proposed for use with the drive system is a type other than NEMA Design A or B, Application Engineering assistance must be requested to make certain that the drive is properly applied.

Controller Selection

The basic requirement of controller selection is to match the output current, voltage and frequency capabilities of the controller with the requirements of the connected motor.

Output Current

The controller must be selected and applied such that the average operating motor current and horsepower do not exceed the continuous current and horsepower ratings of the controller. The intermittent operating current must not exceed the intermittent current rating of the controller.

Motor Protection

Cutler-Hammer adjustable frequency drives include electronic motor overload protection circuits that are designed to meet the requirements of NEC article 430-2 provided that only one motor is connected to the output of the controller.

Output Voltage and Frequency

When they are shipped, AF controllers are adjusted to provide a maximum output voltage and frequency equivalent to the input line voltage and frequency. The controllers can be adjusted to operate above line frequency, but a hazard of personal injury or equipment damage may exist when the motor is operated above base speed. Before adjusting the drive to operate above line frequency, make sure that the motor and the driven machinery can safely be operated at the resulting speed.

Controller Features

Operator Control and Interface Requirements

Since there are many possible configurations and many ways of achieving a specific end result, it pays to consider the operator control and interface requirements carefully. A simplified and more economical drive package can often be achieved by selecting from standard product offerings rather than specifying a custom designed configuration.

Installation Compatibility

The successful application of an AC drive requires the assurance that the drive will be compatible with the environment in which it will be installed. In planning the installation, be sure to carefully consider the heat produced by the drive, the altitude and temperature limits and the need for clean cooling air. Other important considerations include acoustical noise, vibration, electromagnetic compatibility, power quality, controller input harmonic current and power distribution equipment requirements.

Auxiliary Equipment and Accessories

Adjustable drives are generally designed to have a motor directly connected to the controller output terminals with no other equipment connected in series or parallel. Motor starters, disconnect switches, surge absorbers, dv/dt suppression circuits, output chokes, output transformers and any other equipment under consideration for installation on the output of the controller should not be installed without first requesting Application Engineering assistance. Power factor correction capacitors must never, under any circumstances, be connected at the output of the controller. They would serve no useful purpose, and they may damage the controller.

Enclosure Definitions

- **NEMA Type 1** — Enclosures are intended for indoor use primarily to provide a degree of protection against contact with enclosed equipment and provide a degree of protection against a limited amount of falling dirt in locations where unusual service conditions do not exist. Top or side openings in the NEMA Type 1 enclosure allow for the free exchange of inside and outside air while meeting the UL rod entry and rust resistance design tests.
- **NEMA Type 12** — Enclosures are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt and dripping noncorrosive liquids. To meet UL drip, dust and rust resistance tests, NEMA Type 12 enclosures have no openings to allow for the exchange of inside and outside air.
- **Chassis IP00** — Similar to Protected Chassis IP20 except power terminals are protected by plastic shielding only. Primarily intended to be mounted inside a surrounding protective enclosure.
- **NEMA 3R** — Similar in design to NEMA Type 12 except with more stringent design and test requirements.

Motor Protection

DV/DT and Peak Motor Voltage Solutions

Today's AFD products offer significantly improved performance, but at the potential cost of motor insulation stress. The fast switching time of the IGBT devices used in newer AFDs can cause a transmission line effect in the output power leads to the motor, leading to possibly damaging voltage levels. To meet this need, NEMA has introduced a motor in MG1, Part 31, which provides an insulation system designed to maintain normal motor life in AFD applications. For existing motors, a motor protection scheme is required for longer cable runs. Eaton offers three standard solutions for existing systems.

- **MotoR$_X$**
  This patented Cutler-Hammer solution provides an energy recovery system which clamps the peak motor voltage to a safe level for standard motors. This option is used when the distance between a single motor and the drive is 600 feet or less.
- **Output Line Reactor**
  This option provides an output line reactor, reducing the DV/DT of the AFD output voltage and lessening the transmission line effect, to lower the peak voltage at the motor terminals.

Product Availability Codes

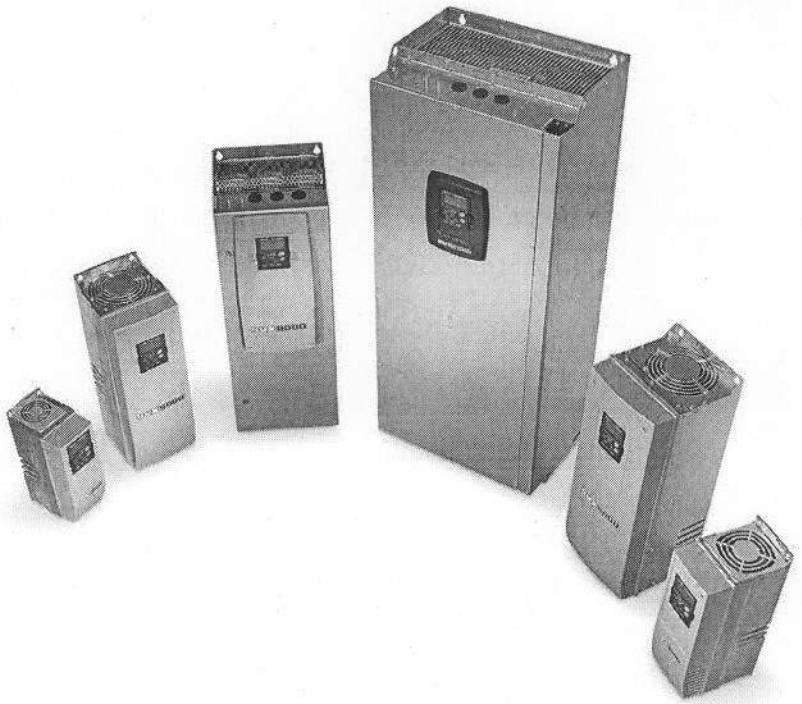
The product availability codes indicate the type of facility (warehouse, Mod Center or factory) that the product will ship from and, if it is not in stock, the number of working days needed to assemble the product from receipt of the order to shipment from the designated facility. Please note that this lead-time does not include any in-transit time from our facility to your facility.

Table 1. Product Availability Codes

Codes	Description
W	Warehouse stocked item. Shipped on customer request date. If item is backordered, please check Vista/VISTALINE or contact your Customer Support Center for product availability.
F1	Factory assemble-to-order. Shipped from factory within 1 working day after receipt of order on Vista.
FA	Factory assemble-to-order. Shipped from factory within 2 – 3 working days after receipt of order on Vista.
FB	Factory assemble-to-order. Shipped from factory within 4 – 10 working days after receipt of order on Vista.
FC	Factory assemble-to-order. Shipped from factory within 11 – 15 working days after receipt of order on Vista.
FD	Factory assemble-to-order. Shipped from factory within 16 – 20 working days after receipt of order on Vista.
FP	Factory assemble-to-order. Shipped from factory on negotiated promise date.
MA	Mod Center assemble-to-order. Shipped from Mod Center within 1 – 3 working days after receipt of order on Vista.
MB	Mod Center assemble-to-order. Shipped from Mod Center within 4 – 10 working days after receipt of order on Vista.
MP	Mod Center assemble-to-order. Shipped from Mod Center on negotiated promise date.

Product availability codes contained herein for a given product may be quantity sensitive and are subject to change without notice. For the most current information, refer to the Product Identification Inquiry (PIN) screen on Vista.

SVX9000 Open Drives



SVX9000 Open Drives

Product Description

Cutler-Hammer® SVX9000 Series Adjustable Frequency Drives from Eaton's electrical business are the next generation of drives specifically engineered for today's commercial and industrial applications. The power unit makes use of the most sophisticated semiconductor technology and a highly modular construction that can be flexibly adapted to the customer's needs.

The input and output configuration (I/O) is designed with modularity in mind. The I/O is compromised of option cards, each with its own input and output configuration. The control module is designed to accept a total of five of these cards. The cards contain not only normal analog and digital inputs but also fieldbus cards.

These drives continue the tradition of robust performance, and raise the bar on features and functionality, ensuring the best solution at the right price.

- The SVX can be flexibly adapted to a variety of needs using our pre-installed "Seven in One" Precision application programs consisting of:
  - ❑ Basic
  - ❑ Standard
  - ❑ Local/Remote
  - ❑ Multi Step Speed Control
  - ❑ PID Control
  - ❑ Multi-Purpose Control
  - ❑ Pump and Fan Control with Auto Change

Features

- Robust design — proven 500,000 hours MTBF
- Integrated 3% line reactors standard on drives from FR4 through FR9
- EMI/RFI Filters H standard up to 200 hp I_H 480V, 100 hp I_H 230V
- Simplified operating menu allows for typical programming changes, while programming mode provides control of everything
- Quick Start Wizard built into the programming of the drive ensures a smooth start-up
- Keypad can display up to three monitored parameters simultaneously
- LOCAL/REMOTE operation from keypad
- Copy/Paste function allows transfer of parameter settings from one drive to the next
- Standard NEMA Type 12 keypad on all drives
- Additional I/O and communication cards provide plug and play functionality
- I/O connections with simple quick connection terminals
- UL Listed
- Hand-Held Auxiliary 240 Power Supply allows programming/monitoring of control module without applying full power to the drive
- Control logic can be powered from an external auxiliary control panel, internal drive functions and fieldbus if necessary
- Brake Chopper standard from:
  1 – 30 hp/380 – 500V
  3/4 – 15 hp/208 – 230V
- NEMA Type 1 and NEMA Type 12 enclosures available, Frame Sizes FR4 – FR9
- Open Chassis FR10 and greater
- NEMA Type 1 and NEMA Type 12 available in FR10 Freestanding design; NEMA Type 1 available in FR11 Freestanding design
- Standard option board configuration includes an A9 I/O board and an A2 relay output board installed in slots A and B

Technical Data and Specifications

Table 2. SVX9000 Specifications

Description	Specification
Input Ratings	
Input Voltage (V_{in})	+10% / -15%
Input Frequency (f_{in})	50/60 Hz (variation up to 45 – 66 Hz)
Connection to Power	Once per minute or less (typical operation)
High Withstand Rating	100 kAIC
Output Ratings	
Output Voltage	0 to V_{in}
Continuous Output Current	I_H rated 100% at 122°F (50°C), FR9 and below I_L rated 100% at 104°F (40°C), FR9 and below I_H/I_L 100% at 104°F (40°C), FR10 and above
Overload Current (I_H/I_L)	150% I_H, 110% I_L for 1 min.
Output Frequency	0 to 320 Hz
Frequency Resolution	.01 Hz
Initial Output Current (I_H)	250% for 2 seconds
Control Characteristics	
Control Method	Frequency Control (V/f) Open Loop: Sensorless Vector Control, Closed Loop: SPX9000 Drives Only
Switching Frequency Frame 4 – 6 Frame 7 – 12	Adjustable with Parameter 2.6.9 1 to 16 kHz; default 10 kHz 1 to 10 kHz; default 3.6 kHz
Frequency Reference	Analog Input: Resolution .1% (10-bit), accuracy ± 1% V/Hz Panel Reference: Resolution .01 Hz
Field Weakening Point	30 to 320 Hz
Acceleration Time	0 to 3000 sec.
Deceleration Time	0 to 3000 sec.
Braking Torque	DC brake: 30% x T_n (without brake option)
Ambient Conditions	
Ambient Operating Temperature	14°F (-10°C), no frost to 122°F (+50°C) I_H (FR4 – FR9) 14°F (-10°C), no frost to 104°F (+40°C) I_H (FR10 and up) 14°F (-10°C), no frost to 104°F (+40°C) I_L (all frames)
Storage Temperature	-40°F (-40°C) to 158°F (70°C)
Relative Humidity	0 to 95% RH, noncondensing, non-corrosive, no dripping water
Air Quality	Chemical vapors: IEC 721-3-3, unit in operation, class 3C2; Mechanical particles: IEC 721-3-3, unit in operation, class 3S2
Altitude	100% load capacity (no derating) up to 3280 ft. (1000m); 1% derating for each 328 ft. (100m) above 3280 ft. (1000m); max. 9842 ft. (3000m)
Vibration	EN 50178, EN 60068-2-6; 5 to 50 Hz, Displacement amplitude 1 mm (peak) at 3 to 15.8 Hz, Max. acceleration amplitude 1G at 15.8 to 150 Hz
Shock	EN 50178, EN 60068-2-27 UPS Drop test (for applicable UPS weights) Storage and shipping: max. 15G, 11 ms (in package)
Enclosure Class	NEMA 1/IP21 or NEMA 12/IP54, Open Chassis/IP20

Description	Specification
Standards	
Product	IEC 61800-2
Safety	UL 508C
EMC (at default settings)	Immunity: Fulfills all EMC immunity requirements; Emissions: EN 61800-3, LEVEL H
Control Connections	
Analog Input Voltage	0 to 10V, R = 200 kΩ (-10 to 10V joystick control) Resolution .1%; accuracy ±1%
Analog Input Current	0(4) to 20 mA; R_i - 250Ω differential
Digital Inputs (6)	Positive or negative logic; 18 to 30V DC
Auxiliary Voltage	+24V ±15%, max. 250 mA
Output Reference Voltage	+10V +3%, max. load 10 mA
Analog Output	0(4) to 20 mA; R_L max. 500Ω; Resolution 10 bit; Accuracy ±2%
Digital Outputs	Open collector output, 50 mA/48V
Relay Outputs	2 programmable Form C relay outputs Switching capacity: 24V DC / 8A, 250V AC / 8A, 125V DC / 0.4A
Protections	
Overcurrent Protection	Trip limit 4.0 x I_H instantaneously
Overvoltage Protection	Yes
Undervoltage Protection	Yes
Earth Fault Protection	In case of earth fault in motor or motor cable, only the frequency converter is protected
Input Phase Supervision	Trips if any of the input phases are missing
Motor Phase Supervision	Trips if any of the output phases are missing
Overtemperature Protection	Yes
Motor Overload Protection	Yes
Motor Stall Protection	Yes
Motor Underload Protection	Yes
Short Circuit Protection	Yes (+24V and +10V Reference Voltages)

Table 3. Standard I/O Specifications

Description	Specification
6 – Digital Input Programmable	24V: "0" ≤ 10V, "1" ≥ 18V,R_i > 5 kΩ
2 – Analog Input Configurable w/Jumpers	Voltage: 0 – ±10V, R_i > 200 kΩ Current: 0 (4) – 20 mA, R_i = 250 kΩ
2 – Digital Output Programmable	Form C Relays 250V AC 2 Amp or 30V DC2 Amp resistive
1 – Digital Output Programmable	Open collector 48V DC 50 mA
1 – Analog Output Programmable Configurable w/Jumper	0 – 20 mA, R_L < 500 ohms, resolution 10 Bits/0.1%